Day-Ahead Market Enhancements

Second Revised Straw Proposal

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Day-Ahead Market Enhancements: Second Revised Straw Proposal

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1. Executive Summary

The objective of this initiative is to enhance the California ISO's (CAISO's) day-ahead market by:

- Introducing in the integrated forward market an imbalance reserve product to procure flexible capacity to cover real-time ramping needs that are not covered by hourly day-ahead market schedules and to cover real-time net load uncertainty.
- Enhancing the residual unit commitment process to ensure there is sufficient downward dispatch capability in the event real-time load is less than scheduled in the integrated forward market.

This paper describes the CAISO's proposed day-ahead market design enhancements. The integrated forward market will co-optimize energy and ancillary services as it currently does, while also including imbalance reserves within the same optimization to reserve resources' ramp capability for real-time dispatch.

Imbalance reserves will ensure the day-ahead market schedules sufficient real-time dispatch capability to meet net load imbalances that materialize between the day-ahead and real-time markets. These imbalances are due to net load uncertainty and granularity differences between the hourly day-ahead market schedules and real-time market schedules. These imbalances have increased in recent years because of increasing amounts of variable energy resources. This increasing net load uncertainty has caused system operators to utilize more out-of-market actions to maintain reliability such as increasing the residual unit commitment forecast, making exceptional dispatches, and increasing the load forecast in the real-time market.

Under the proposed enhancements, an imbalance reserve award will obligate a supplier to provide economic energy bids in the real-time market. Only resources that can be dispatched in the fifteen-minute market will be able to provide imbalance reserves.

The market will consider transmission constraints to ensure imbalance reserves are deliverable. Modeling these transmission constraints will consider the resultant energy flows if the imbalance reserves are deployed. Consequently, the imbalance reserves will, similar to energy, have a locational marginal price.

The CAISO also proposes enhancements to the residual unit commitment process in this initiative. The existing residual unit commitment process ensures sufficient physical resources are committed to meet the net load forecast while considering transmission constraints. The CAISO will continue to run the existing residual unit commitment process after the integrated forward market co-optimizes energy, ancillary services, and imbalance reserves. However, the CAISO proposes to enhance the residual unit commitment process to also provide downward dispatch capability and/or avoid committing resources if the net load forecast is less than the net load that clears the integrated forward market. This incremental or decremental capacity awarded in the residual unit commitment process would be referred to as *reliability capacity up or reliability capacity down*, respectively. A reliability capacity

award will obligate the resource to provide economic energy bids to the real-time market so that the resource's dispatch capability is available in real time.

Under the proposed enhancements, suppliers will provide price and quantity bids for capacity availability in both the upward and downward direction that the market will use to award both reliability capacity and imbalance reserves. Resources awarded reliability capacity or imbalance reserves will receive a day-ahead payment at the locational marginal price for the relevant product. Ramping capability provided by imbalance reserve awards and forecasted movement in the day-ahead market will be settled against forecasted movement and flexible ramping product in the real-time market. The residual unit commitment process will include market power mitigation to address potential market power in providing this locational reliability capacity product. The market will recover the costs of these products through a cost allocation that collects payments from entities based on their contribution to the need to procure the product.

In addition to procuring downward capacity, the CAISO also proposes to enhance the residual unit commitment process to establish the binding configuration for multi-stage generating resources.

The new day-ahead market design will be the foundation for extending the day-ahead market to Western Energy Imbalance Market participants outside of the CAISO's balancing authority area. The stakeholder process for this initiative is concurrently underway.[1]

2. Changes from Revised Straw Proposal

The CAISO published the Day-Ahead Market Enhancements (DAME) revised straw proposal on June 6, 2020 and held two web meetings to discuss the proposal on June 15 and 17, 2020.

The revised straw proposal continued to introduce reliability capacity and imbalance reserves to the day-ahead market. However, the revised straw proposal pivoted away from the *reliability energy (REN)* concept. The revised straw proposal proposed to arrive at the day-ahead market solution through two market passes. The first market pass solved the optimal unit commitment to clear bid-in load, bid-in supply, imports, exports, ancillary services requirements, the net load forecast, and the imbalance reserve requirement. The first pass determined the amount of reliability capacity up (RCU) or reliability capacity down (RCD) needed to cover the difference between non-variable energy resource (VER) physical supply and the net load forecast. This then allowed the RCU or RCD quantity to be a fixed requirement in the second market pass to decouple the price of reliability capacity and energy.

The revised straw proposal also introduced two other important design elements. The first was a proposal to have a real-time energy offer price cap for resources awarded reliability capacity up and imbalance reserves up. The objective of the offer cap was to distinguish the energy cost of resources when awarding reliability capacity and imbalance reserves. The offer cap was intended to incentivize

[1] CAISO Extended Day-Ahead Market Initiative. http://www.caiso.com/StakeholderProcesses/Extended-day-ahead-market

resources with high energy costs to increase their capacity bid price and thus be less likely to be awarded capacity products. The second design element addressed potential locational market power of the new capacity products. The revised straw proposal was to mitigate capacity bids to $30/MWh if market power was detected in the upward or downward deployment scenario. $30/MWh represented the 90th percentile historical spin price, which was assumed to represent a competitive capacity price.

On the stakeholder call on June 15, stakeholders pointed out that fixing the reliability capacity requirement in the second market pass could result in virtual supply displacing physical supply. This occurs because the second market pass does not consider the tradeoff between virtual supply and reliability capacity. Based on this feedback, the CAISO proposed to modify the day-ahead market formulation to introduce a third market pass. This third pass updated the reliability capacity requirement based on any displacement of physical supply in the second pass. This extra step ensured the reliability target was met.

However, when testing the proposed multi-pass day-ahead market approach with a decoupled reliability capacity constraint, the CAISO uncovered several issues:

- The multi-pass approach did not preserve the cost benefits of the fully coupled pass (pass 1). The CAISO found the solution could be very different from that of the fully coupled pass and with a much higher associated market-clearing cost.
- There was a possibility of not reaching a solution with the multi-pass approach. The CAISO observed instances in which the proportions of virtual and physical supply kept changing as the decoupled reliability capacity constraint was updated.
- The CAISO considered the possibility of fixing the commitments after the fully coupled pass to try to preserve some aspects of this efficient solution and help with convergence, but found that this was too restrictive and could lead to high cost inefficiencies, and even reliability capacity shortages in the subsequent passes.

To achieve an efficient solution, the CAISO has determined it necessary to implement a fixed reliability capacity requirement, which necessitates a return to a sequential IFM-RUC approach. That is because the reliability capacity requirement cannot be known until after the integrated forward market has run.

Considering a new approach, it is important to remember the conditions that originally motivated the CAISO and stakeholders to reconsider the current day-ahead market design. System operators continue to systematically increase the net load forecast used in the residual unit commitment process so that it commits additional resources to help address net load uncertainty and to provide additional real-time ramp capability. If the residual unit commitment were able to perform its intended purpose, it would be meeting the system's reliability capacity needs without these net load forecast adjustments. The issue is the day-ahead market currently lacks a product that provides capacity to help address net load uncertainty and provide additional real-time ramp capability. Consequently, this second revised straw proposal continues to propose a new imbalance reserve up/down product in the integrated forward market to provide real-time ramping capability and address net load uncertainty. This will greatly

decrease the need for system operators to adjust the load forecast used in the residual unit commitment process.

The CAISO also proposes to make enhancements to the current residual unit commitment process. These enhancements include the ability to:

- Procure reliability capacity down
- Establish the binding configuration for multi-stage generating resources
- Include market power mitigation to address potential market power in providing reliability capacity.

The sequential approach decouples energy and reliability capacity by maintaining a separate integrated forward market and residual unit commitment. The integrated forward market will continue to be a financial energy market that clears bid-in demand against bid-in supply while also meeting ancillary services and imbalance reserve requirements. If necessary, the residual unit commitment would provide additional unit commitment to ensure physical supply is available in real time to meet the CAISO net load forecast.

This proposal introduces an additional market power mitigation pass to the residual unit commitment process to assess the competitiveness of reliability capacity bids and mitigate reliability capacity bid prices if uncompetitive conditions are found. Any mitigated reliability capacity bids would be inputs into the residual unit commitment process. The previous proposal was to mitigate reliability capacity bids in the market power mitigation pass run before the integrated forward market when the imbalance reserve deployment scenarios were binding.

This proposal updates the way imbalance reserves are procured in the integrated forward market. The previous proposal was to procure imbalance reserves with a demand curve. With a demand curve, the market would have weighed the tradeoff between high imbalance reserve prices and the expected cost of reducing the imbalance reserve requirement. The current proposal is no longer to use a demand curve and to procure 100 percent of the imbalance reserve requirement. The imbalance reserve requirement will be relaxed at a penalty price lower than self-scheduled load and ancillary services but higher than low-priority self-scheduled exports. This ensures that high-priced economic bid exports and low-priority self-scheduled exports do not crowd out procurement of imbalance reserves needed to meet CAISO uncertainty and ramping needs.

This proposal introduces a deviation settlement for ramping procured as either forecasted movement or imbalance reserves in the integrated forward market with forecasted movement and flexible ramping product procured in the real-time market. This deviation settlement is intended to eliminate double payments for forecasted movement imbedded in day-ahead energy prices and energy opportunity cost imbedded in uncertainty awards that are possible without a deviation settlement. This proposal also introduces a no-pay mechanism for imbalance reserves that are unavailable in the real-time market.

This proposal updates the process for mitigating imbalance reserve bids in the market power mitigation pass. The previous proposal was to mitigate all imbalance reserve bids based on a *default capacity bid*

of $30 (representing the 90th percentile spinning reserve price) when conditions are uncompetitive. Stakeholders opposed this proposal because 1) the 90th percentile spinning reserve price was perceived by stakeholders as being too high and 2) a single mitigation price could result in mitigating prices below competitive levels at certain locations. The new proposal addresses the first concern by providing data on percentiles of historical spinning reserve bids and clearing prices and soliciting stakeholder feedback as to which price level best represents an appropriate default capacity bid. The new proposal addresses the second concern by calculating a *competitive capacity price* similar to the competitive locational marginal price used in energy offer mitigation. Imbalance reserve bids would then be mitigated to the higher of the two prices.

This proposal updates the requirement for variable energy resource eligibility for reliability capacity and imbalance reserve awards. Based on stakeholder feedback, the CAISO proposes that variable energy resources will be able to provide reliability capacity up and imbalance reserve up if the scheduling coordinator submits bids consistent with the CAISO's variable energy resource forecast. The CAISO's variable energy resource forecast will set the resource's upper economic limit used in the market. This upper economic limit sets the maximum quantity of energy and upward capacity a resource can be awarded. Variable energy resources will be eligible to provide reliability capacity down and imbalance reserve down whether or not their bids are consistent with the CAISO's variable energy resource forecast.

This proposal updates the how the market will account for a resource's underlying energy cost when awarding upward capacity products (i.e., reliability capacity up and imbalance reserves up). The previous proposal was to establish a real-time market energy offer cap for resources awarded reliability capacity up or imbalance reserves up. The offer cap would be set at the marginal price of meeting the P97.5 net load forecast using all available day-ahead energy bids. This offer cap would incentivize resources with high underlying energy costs to submit higher bids for reliability capacity up and imbalances reserves up. Stakeholders objected that this offer cap was too complicated to form their bids around and could adversely affect price formation. The current proposal is a simpler and more direct way of meeting the same objective. The CAISO proposes to make resources ineligible for reliability capacity up/imbalance reserve up awards on any capacity segment with an associated energy bid that exceeds the calculated P97.5 net load price.

This proposal also removes mention of corrective capacity as a biddable market product as this product is no longer planned to be implemented in the market.

Table 1 summarizes the remaining design changes from the previous proposal.

Table 1: Changes from Previous Proposal

Topic	Previous Proposal	New Proposal	Rationale
Day-Ahead Market Formulation	Integrated IFM and RUC with multiple passes and a decoupled reliability capacity constraint.	Sequential IFM and RUC.	Testing of the multi-pass formulation revealed several insurmountable issues.

Day-Ahead Market Formulation	A single MPM pass before IFM will mitigate energy, imbalance reserve, and reliability capacity offers.	An MPM pass run before IFM will mitigate energy and imbalance reserve offers and a separate MPM pass run before RUC will mitigate reliability capacity offers.	Using the status quo MPM pass to mitigate reliability capacity offers when imbalance reserve deployment scenarios are uncompetitive is suboptimal compared to using the RUC optimization to determine whether reliability capacity offers are uncompetitive.
Imbalance Reserve Procurement	The day-ahead market will procure imbalance reserves based on a demand curve.	The day-ahead market will procure the entire imbalance reserve requirement and set the relaxation penalty price below the power balance constraint but above low-priority (LPT) self-scheduled exports.	Using a demand curve may cause low-priority self-scheduled exports or exports with high economic bids to clear before meeting the full imbalance reserve requirement. This may cause system operators to continue to perform the out-of-market actions that imbalance reserves are intended to prevent.
Imbalance Reserve Settlement	No ramp deviation settlement proposed.	Deviation settlement between forecasted movement/imbalance reserve awards in the day-ahead market and forecasted movement/flexible ramping product in the real-time market.	Prevents double payment of forecasted movement and energy opportunity costs and incentivizes following day-ahead schedules.
Imbalance Reserve Unavailability	No imbalance reserve unavailability no-pay mechanism proposed.	Resources with an upper economic limit that does not support their day-ahead energy + IRU award less the 5-minute portion of their imbalance reserve award in IFM will be charged the higher of the RTPD FRU price, the RTD FRU price, or the IRU price.	A stronger incentive than a simple no-pay is needed to ensure resources follow through on their must-offer obligations.
Market Power Mitigation	Mitigate capacity bids to maximum of $30 or $30 plus the resource's	The CAISO proposes to calculate a "competitive capacity price" for	Aligns mitigation of imbalance reserve bids with energy bids and

	default energy bid minus the real-time energy offer cap. $30 represents the 90th percentile spin price, which represents a competitive capacity price.	imbalance reserves that excludes non-competitive congestion prices similar to the competitive locational marginal price used in energy offer mitigation. The CAISO seeks stakeholder input on the appropriate spinning reserve price percentile that approximates actual availability costs.	responds to stakeholder feedback that 90th percentile spin price was too high and objections to a single mitigation price.
Variable Energy Resources (VERs)	VERs are ineligible to provide RCU and IRU.	VERs can provide RCU and IRU if they use the CAISO VER forecast.	Stakeholders desired the ability for VERs to provide upward capacity products.
Accounting for Energy Offer Cost in Upward Capacity Procurement	Implement a real-time energy offer cap for resources awarded RCU and/or IRU. The offer cap would be set at the marginal price of meeting the P97.5 net load forecast using all available day-ahead energy bids.	Implement a SIBR rule such that resources would be ineligible for RCU/IRU awards on any capacity segment with an associated energy bid that exceeds the calculated P97.5 price.	Stakeholders were opposed to previous proposal and new proposal solves same objective more directly and simply.
Contingency Modeling Enhancements (CME)	Previous straw proposals added a bidding component to CME (i.e., corrective capacity up and corrective capacity down).	This component has been removed from implementation.	FERC agreed to release the CAISO from its commitment to implement Contingency Modeling Enhancements.[2]

3. Need for Day-Ahead Market Enhancements

This section explains why a redesign of the day-ahead market is necessary. Historically, the CAISO balancing authority area consisted of a predictable generation fleet. Resources were scheduled hourly in the day-ahead market and changes (or *imbalances*) were addressed in the real-time market. Over the last 10 years, variable energy resources (i.e., wind and solar resources) have become more prevalent.

[2] Federal Energy Regulatory Commission. Order Amending Order Approving Stipulation and Consent Agreement. Docket No. IN14-10-000. Issued February 26, 2021. http://www.caiso.com/Documents/Feb26-2021-OrderAmendingOrderApprovingStipulationConsentAgreement-Sep8-9-2011SouthwestPowerOutage-IN14-10.pdf

While these resources are critical in meeting renewable energy and carbon emission goals, they also introduce supply uncertainty and can create challenging conditions for system operators to manage.

Energy imbalances can occur for two reasons. First, the day-ahead market schedules energy with less time granularity than the real-time market. The day-ahead market produces hourly energy schedules while the real-time market produces fifteen- and five-minute schedules. These granularity differences cause imbalances because the real-time market schedules fluctuate within the hour while the day-ahead market schedules do not. The real-time market ramping need can be at faster ramp rates than what the day-ahead market scheduled to meet ramping needs between hourly schedules. Second, there is uncertainty in the net load that will materialize between day-ahead and real-time market runs. The day-ahead market net load forecast cannot perfectly predict the actual net load during the operating day. Any differences between what was predicted and what actually occurred results in imbalances.

The real-time market must manage energy imbalances that occur between the day-ahead and real-time markets. The real-time market will continue to serve this purpose under the redesigned day-ahead market. The CAISO proposes a new day-ahead market product called "imbalance reserves" to better accommodate net load imbalances. The new day-ahead market will co-optimize energy, ancillary services, and imbalance reserves. The market will preserve the existing sequential integrated forward market and residual unit commitment structure, but will include enhancements to the residual unit commitment process to maintain reliability in the real-time market more effectively.

3.1. Improve Market Efficiency

Changes between the day-ahead market and real-time market are inevitable. As the market approaches real time, the load forecast is updated and output from renewable resources may change. Imbalances occur for many reasons including weather changes, outages, and forecasting inaccuracies. Ultimately, the CAISO is responsible for responding to imbalances across markets to ensure load is served reliably at all times.

Large imbalances between the day-ahead and real-time market can result in challenging conditions for system operators. When there is a risk that imbalances are too large to address through the real-time market, system operators must rely on out-of-market actions to cover these imbalances. These actions may include increasing the load forecast in the market and/or issuing exceptional dispatches. Although these actions are necessary for grid reliability, they also undermine market price formation and dilute the economic signals provided by market prices. For example, assume additional supply with a minimum power output (PMin) of 100MW is committed after the day-ahead market to cover uncertainty. If the uncertainty materializes less than the PMin, there will be price divergence between the day-ahead market and real-time market. Price divergences occur because resources with day-ahead energy schedules will need to be dispatched lower, leading to lower real-time prices relative to day-ahead prices. The proposed imbalance reserve product will reduce the need for out-of-market actions and incorporate these costs into day-ahead market clearing prices. This will compensate resources more appropriately for providing this capacity and improve price convergence between the day-ahead market and real-time market.

Ultimately, the CAISO market should achieve grid reliability through efficient and effective market solutions. The day-ahead market enhancements initiative moves the day-ahead market closer to that goal by introducing a new product to procure capacity that would otherwise be obtained through out-of-market actions. This capacity can then be accurately priced through the market clearing process.

3.2. Price Performance Analysis Report

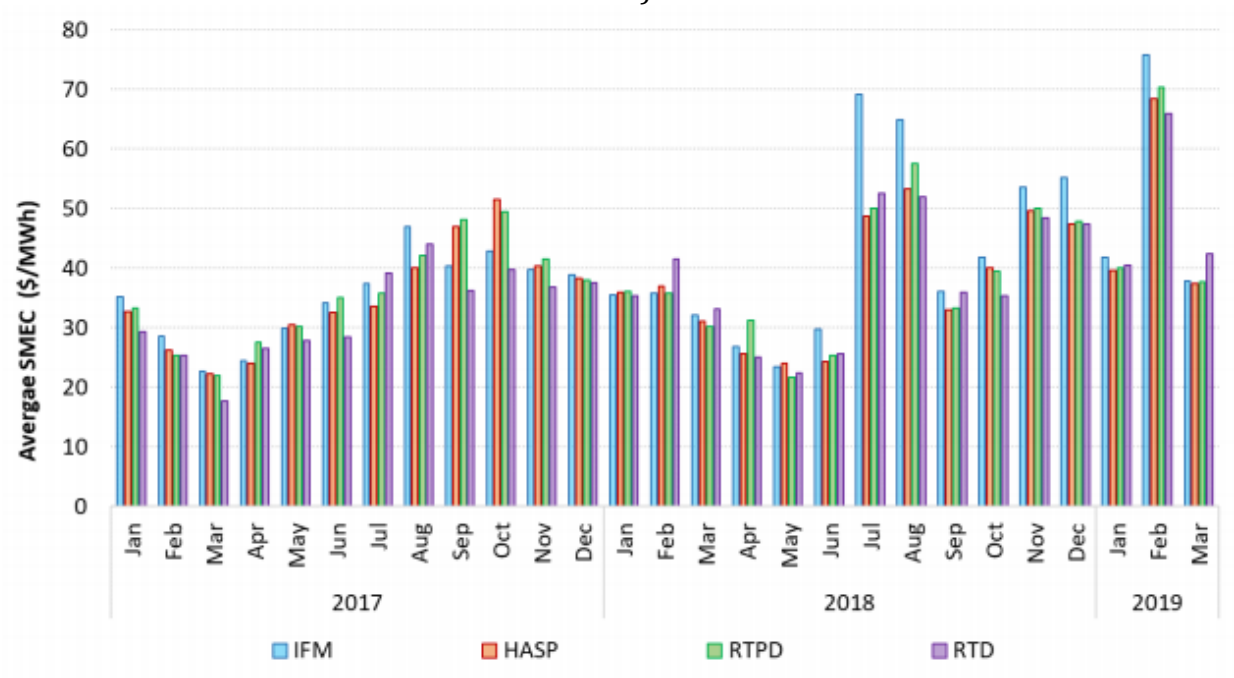
The CAISO completed a comprehensive report titled *Price Performance Analysis* that summarized and analyzed price formation in the CAISO markets.[3] The report identified factors that contribute to price differences between the day-ahead and real-time markets and proposed solutions to mitigate potential inefficiencies.

As a part of this effort, the report analyzed imbalances across market runs. The greatest magnitude of imbalance occurs between the day-ahead and fifteen-minute market (as opposed to between the fifteen-minute market and the five-minute market). These imbalances can be as large as 6,000 MW in a single hour. The *Price Performance Analysis* report confirmed that large imbalances between the day-ahead and real-time market occur because of load forecast error and variable energy resource output changes. As shown in Figure 1, the "IFM prices are persistently higher than real-time prices starting in 2018 and continue in 2019."[4] CAISO believes this occurs because operators use out-of-market actions to procure additional capacity to meet potentially large imbalances. These out-of-market actions may then lead to lower prices in the real-time market relative to the day-ahead market.

[3] CAISO Energy Markets Price Performance Report. September 23, 2019. http://www.caiso.com/Documents/FinalReport-PricePerformanceAnalysis.pdf

[4] Ibid., page 22

Figure 1: Pricing differences across day-ahead and real-time markets (Jan 2017 – Mar 2019)



Source: Price Performance Report, Page 22

Sustained price differences are a signal that the market is not functioning optimally. The actions the CAISO must take outside of the market to ensure grid reliability contribute to price differences. While the CAISO must operate the system reliably, the CAISO also recognizes that consistent out-of-market actions signal there may be gaps in the current market design. Ultimately, the CAISO's goal is to produce a market solution that accurately reflect costs and system conditions, and is consistent with reliable operations.

The *Price Performance Analysis* report identifies the Day-Ahead Market Enhancements initiative as an opportunity to address the large imbalances between markets and reduce operator out-of-market actions. One of the goals of this initiative is to identify and implement enhancements to the day-ahead market design that will enhance price convergence between markets.

3.3. Historical Imbalances between Day-Ahead and Real-Time Markets

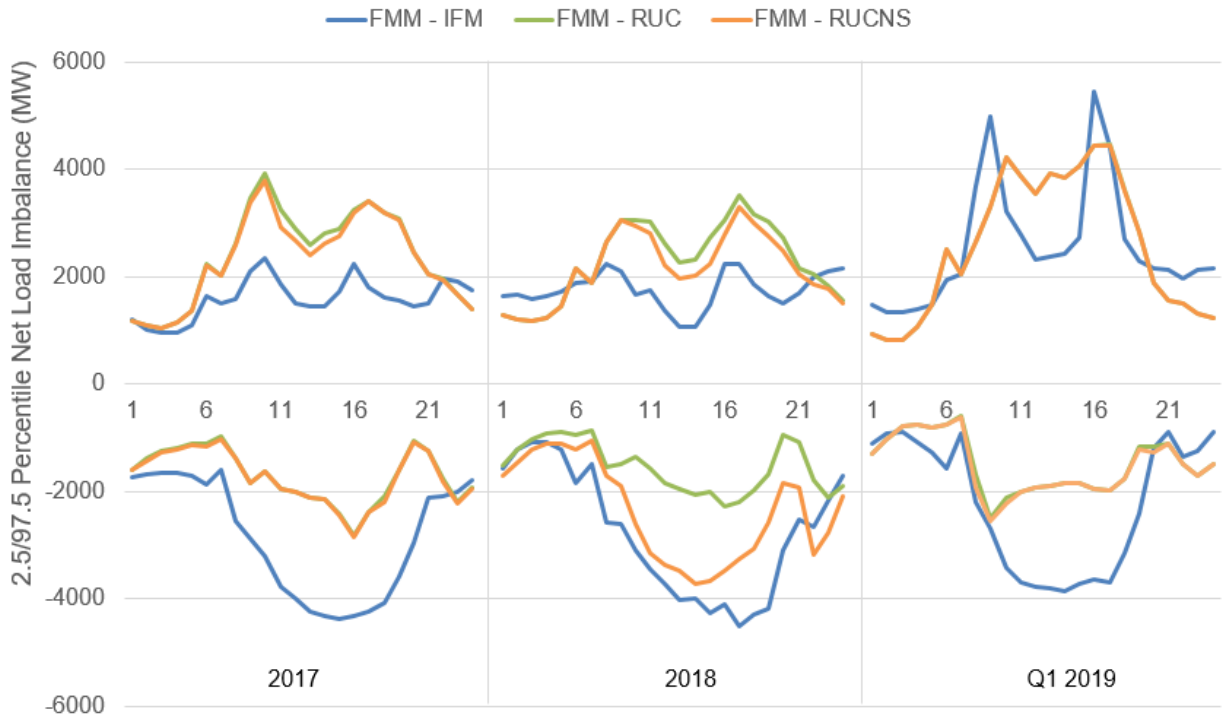
This section illustrates the magnitude of net load imbalances that occurred between the day-ahead market and the fifteen-minute market using data from January 2017 to March 2019. Net load imbalance values were calculated in each fifteen-minute interval for each of the following reference points:

1. The net load that clears the integrated forward market (cleared demand and virtual bids minus cleared variable energy resource bids).
2. The day-ahead net load forecast (day-ahead load forecast minus day-ahead variable energy resource forecast), not including operator forecast adjustments (i.e., residual unit commitment net short adjustment process).

3. The day-ahead net load forecast, including operator forecast adjustments.

Figure 2 shows historical net load imbalances by hour and year at the 2.5 and 97.5 percentiles. This means that 95 percent of the observed historical differences lie between these values.

Figure 2: Historical net load imbalance (Jan 2017 – Mar 2019)



Source: CAISO analysis

4. Proposed Day-Ahead Market Enhancements

Overview

The day-ahead market currently consists of three sequential market passes:

1. Market power mitigation (MPM) pass
2. Integrated forward market (IFM) pass
3. Residual unit commitment (RUC) pass

Market power mitigation identifies potentially uncompetitive bids and mitigates them accordingly to ensure prices remain competitive throughout the system. Nothing is scheduled or dispatched because of market power mitigation. The results of the first market power mitigation pass are used as inputs to the integrated forward market pass. In the event market power is detected in the first market power mitigation pass, energy and imbalance reserve bids will be mitigated.

The integrated forward market uses supply and demand bids to determine the amount of energy that will clear in the day-ahead market. Convergence bids, also known as virtual supply and virtual demand

bids, are allowed to participate in this financial market. The integrated forward market also procures ancillary services and commits resources to meet the CAISO's ancillary service requirements. The integrated forward market pass co-optimizes energy and ancillary services to produce financially binding day-ahead schedules and ancillary services awards. The CAISO proposes in this initiative to add an imbalance reserves up and down product to the integrated forward market with a requirement based on historical uncertainty between the day-ahead and real-time markets.

The residual unit commitment pass bridges the gap between the CAISO's load forecast and the physical energy cleared in the integrated forward market by procuring incremental capacity that was not scheduled or awarded in the integrated forward market. This additional capacity ensures the grid will remain reliable in real time. The residual unit commitment process also looks ahead and issues advisory commitment instructions for resources with start times greater than 18 hours.

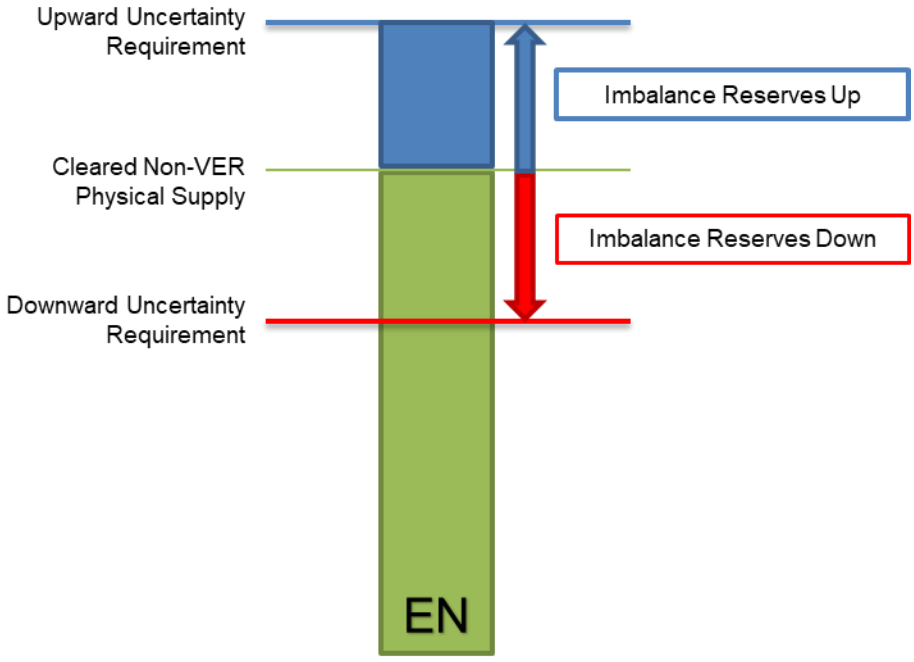
Previous proposals from the *Day-Ahead Market Enhancements* initiative explored integrating the integrated forward market and the residual unit commitment process into a single market pass. The products procured in both markets would be co-optimized in a single market solution. Due to technical challenges and stakeholder feedback, the CAISO no longer proposes a co-optimized integrated forward market and residual unit commitment process. This proposal instead proceeds with the existing, sequential market structure. However, the CAISO continues to propose to enhance the existing residual unit commitment process by procuring both reliability capacity up and down to commit resources to meet differences between cleared net physical supply and the CAISO's net load forecast. The CAISO also proposes to include a market power mitigation pass before the residual unit commitment to assess competitiveness of reliability capacity and potentially mitigate reliability capacity bids. The results of the new second market power mitigation pass will be used as inputs to the residual unit commitment pass. In the event market power is detected in the second market power mitigation pass, reliability capacity bids will be mitigated.

New Day-Ahead Market Products

This second revised straw proposal continues to propose imbalance reserves as a new market product to address ramping differences and net load uncertainty between the day-ahead and real-time markets. Imbalance reserves will minimize the need for out-of-market actions and appropriately value resources' flexible capacity. However, unlike under previous proposals, the CAISO proposes to preserve the sequential integrated forward market and residual unit commitment process. The CAISO also proposes to enhance the residual unit commitment process by adding a downward reliability capacity product.

Figures 3, 4 and 5 represent the relationship between energy and imbalance reserves (procured in the integrated forward market) and reliability capacity (procured in the residual unit commitment process). Figure 3 illustrates the scenario where the integrated forward market clears non-VER physical supply equal to the CAISO's net load forecast. The market will procure imbalance reserves to cover upward and downward uncertainty requirements. The day-ahead market would not need to procure reliability capacity in the residual unit commitment process.

Figure 3: Day-ahead market products when forecast is equal to non-VER physical supply



However, rarely will the non-VER physical supply clear equal to the net load forecast.[5] Several factors contribute to this and thus drive the need for the residual unit commitment to procure reliability capacity. The drivers for reliability capacity up are:

- Bid-in load clears the integrated forward market less than the CAISO load forecast
- Virtual supply clears the integrated forward market in excess of virtual demand
- Variable energy resources clear the integrated forward market greater than the CAISO variable energy resource forecast

The drivers for reliability capacity down are:

- Bid-in load clears the integrated forward market greater than the CAISO load forecast
- Virtual demand clears the integrated forward market in excess of virtual supply
- Variable energy resources clear the integrated forward market less than the CAISO variable energy resource forecast

These drivers can also offset each other. For example, virtual demand may clear to address under-scheduled load and virtual supply may clear to address under-scheduled variable energy resources.

Figure 4 illustrates this relationship when the CAISO's net load forecast is greater than the cleared non-VER physical supply. When this occurs, the residual unit commitment procures reliability capacity up to

[5] The CAISO developed an Excel spreadsheet illustrating how cleared energy schedules determine the reliability capacity imbalance reserve need. The spreadsheet is posted on the CAISO website with the revised straw proposal.

provide upward dispatch capability, relative to the energy schedules, to meet the net load forecast. The integrated forward market still procures the full imbalance reserve requirements to meet the upward and downward uncertainty.

Figure 4: Day-ahead market products when forecast is greater than non-VER physical supply

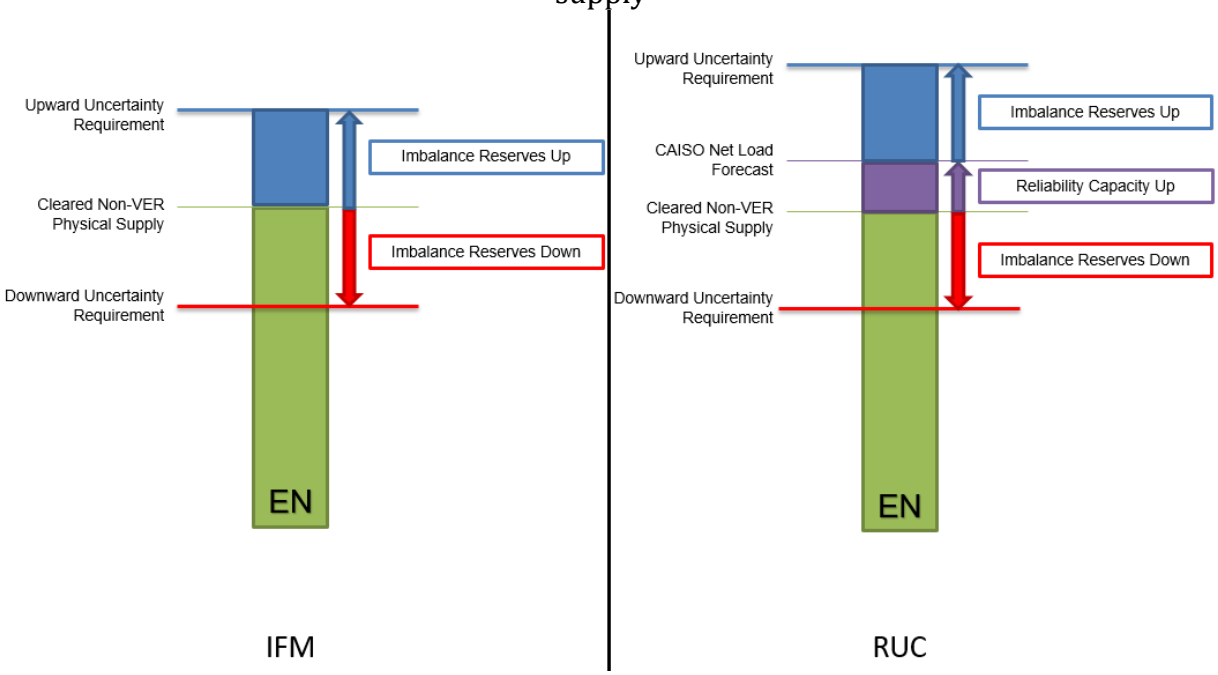
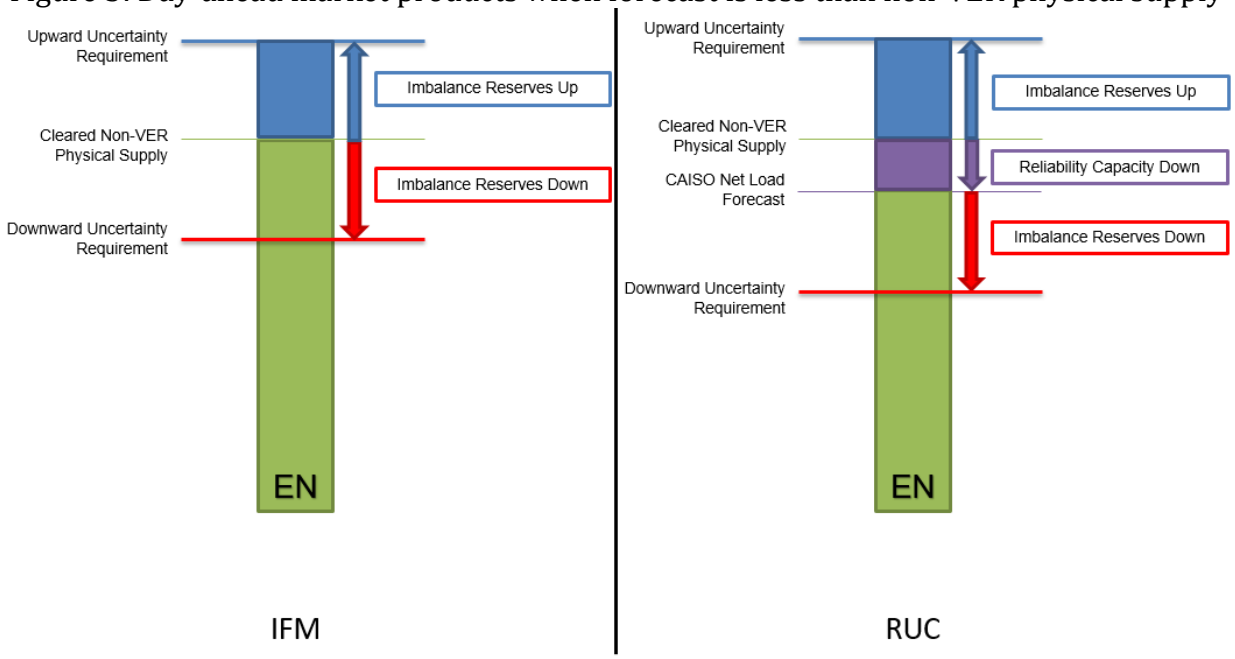


Figure 5 illustrates this relationship when the CAISO's net load forecast is less than the cleared non-VER physical supply. When this occurs, the residual unit commitment procures reliability capacity down to provide downward dispatch capability, relative to the energy schedules, to meet the net load forecast. The integrated forward market still procures the full imbalance reserve requirements to meet the upward and downward uncertainty.

Figure 5: Day-ahead market products when forecast is less than non-VER physical supply



The net load forecast and the amount of net load uncertainty determines the amount of physical energy and dispatch capability from physical resources needed to ensure reliability.

Table 2 Table 2summarizes the proposed day-ahead market products. It also includes the existing and planned day-ahead market products for completeness.

Table 2: Proposed and existing day-ahead market products

Title	Acronym	Time Domain	Purpose	Eligibility*	Procured In	Status
Energy	EN	Hourly	Energy schedules cleared to meet bid-in demand	All resources	IFM	Existing
Reliability Capacity, Up	RCU	Hourly	Incremental capacity procured to meet the positive difference between the net load forecast and cleared non-VER physical supply	Physical resources based on 60-minute ramp capability	RUC	Replaces RUC awards

Title	Acronym	Time Domain	Purpose	Eligibility*	Procured In	Status
Reliability Capacity, Down	RCD	Hourly	Decremental capacity procured to meet the negative difference between net load forecast and cleared non-VER physical supply	Physical resources based on 60-minute ramp capability	RUC	Proposed
Imbalance Reserves, Up	IRU	15-min	Incremental capacity procured relative to the net load forecast to meet the upward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	IFM	Proposed
Imbalance Reserves, Down	IRD	15-min	Decremental capacity procured relative to the net load forecast to meet the downward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	IFM	Proposed
Ancillary Services	AS	10-min	Incremental capacity procured and reserved to meet real-time regulation and contingency reserve requirements	Resources certified to provide the respective service	IFM	Existing

Real-Time Bidding Obligations based on Day-Ahead Awards

Resources that receive an energy schedule, ancillary service awards, reliability capacity awards, or imbalance reserve awards in the day-ahead market will have real-time market bidding obligations. Resources must economically bid the full range of their reliability capacity and imbalance reserve awards in the real-time market. Real-time must offer obligations apply in the hours that a resource has a reliability capacity or imbalance reserve award.

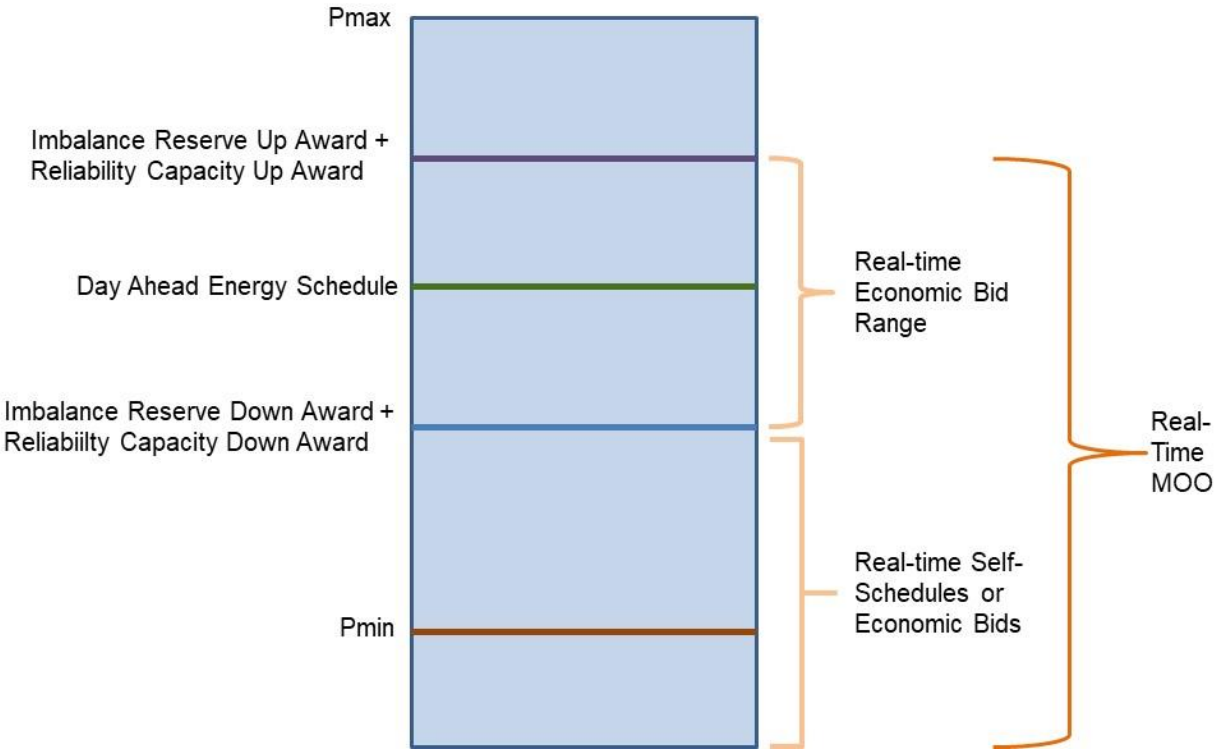
The purpose of the real-time must offer obligation is to provide economic bids to the real-time market. Economic bids enable the real-time market to re-dispatch resources to meet real-time system conditions and imbalances. Real-time self-schedules do not provide the real-time market with the ability to re-dispatch the resource.

The minimum real-time bidding obligations are illustrated in Figure 6. A resource must submit economic bids above its day-ahead energy schedule by the amount of imbalance reserves up and reliability capacity up awarded. The resource is not required to submit additional bids up to its Pmax but may elect to do so. This ensures there are sufficient economic offers to allow the real-time market to dispatch the resource above its day-ahead energy schedule.

Any portion of this resource's day-ahead energy schedule below the imbalance reserves down and reliability capacity down awards can be either self-scheduled or economically bid. A resource cannot submit a self-schedule that exceeds its energy schedule less its imbalance reserves down and reliability capacity down awards. This ensures that there are sufficient economic offers to allow the real-time market to dispatch the resource below its day-ahead energy schedule.

A resource that can be committed in the real-time market can submit start up and minimum load bids to enable the market to re-optimize the unit commitment decision. This is not a requirement because the resource can elect to self-schedule a portion of its output.

Figure 6: Real-time bidding obligations



Resource Adequacy Day-Ahead Must Offer Obligations

The following summarizes the resource adequacy must offer obligations for the day-ahead market. Additional rules are being developed in the Resource Adequacy Enhancements initiative.[6]

Resource adequacy resources will continue to be required to bid their resource adequacy capacity into the day-ahead market. Resources providing system and local resource adequacy will be required to bid or self-schedule for energy and bid or self-provide ancillary services. Additionally, resources providing system and local resource adequacy will be required to bid for reliability capacity. The resource adequacy requirements will also have to ensure that resource adequacy resources provide sufficient imbalance reserve capacity bids to meet the imbalance reserve requirements. This will require either redefining the flexible resource adequacy product and/or developing enhanced economic bidding rules for system resource adequacy resources. Resource adequacy rule changes to align the resource adequacy requirements with the Day-Ahead Market Enhancements are being developed in the Resource Adequacy Enhancements initiative as part of phase 2 that will be on the same timeline as the Day-Ahead Market Enhancements.

[6] CAISO Resource Adequacy Enhancements initiative.
https://stakeholdercenter.caiso.com/StakeholderInitiatives/Resource-adequacy-enhancements

If a resource economically bids its entire resource adequacy obligation for energy and ancillary services, the resource must bid for reliability capacity. It will be optional for resources providing system and local resource adequacy to bid for imbalance reserves.

If a portion of the resource is self-scheduled for energy or ancillary services, the resource will be required to economically bid the rest of the resource's obligation for energy, ancillary services, and reliability capacity.

Resource adequacy resources will have the same real-time must offer obligation as any other resource based upon day-ahead awards after the proposed transition period expires (see Section 4.8).

Day-Ahead Market Enhancements Design Details

The remainder of this section describes the proposed day-ahead market enhancements and is organized as follows:

- Section 4.1 describes the proposed changes to the market power mitigation pass for the integrated forward market.
- Section 4.2 describes the proposed changes to the integrated forward market.
- Section 4.3 introduces and describes an additional market pass to perform market power mitigation for the residual unit commitment process.
- Section 4.4 describes the proposed changes to the residual unit commitment process.
- Section 4.5 introduces and describes the real-time market settlement of ramp deviations.
- Section 4.6 describes additional market design details.

4.1 Market Power Mitigation Pass for IFM Changes

In the market power mitigation pass for IFM, the market will use unmitigated bids to clear bid-in load, bid-in supply, imports, exports, ancillary services requirements, and the imbalance reserve requirements. Binding transmission constraints in the base scenario (cleared bid-in load), the imbalance reserve up deployment scenario, and the imbalance reserve down deployment scenario are evaluated to determine if they are uncompetitive. Resources with a net positive marginal congestion contribution from uncompetitive constraints will have their energy and/or imbalance reserve bids mitigated. Energy marginal prices have congestion contributions from all binding constraints in all scenarios, whereas imbalance reserve up and down marginal prices have congestion contributions only from binding constraints in the imbalance reserve up and down deployment scenarios, respectively. Energy and/or imbalance reserve bids are mitigated above the corresponding competitive marginal price, which is the marginal price without contributions from uncompetitive binding constraints.

The CAISO mitigates supply offers to the greater of what it calls "default energy bids" or the competitive locational marginal price. Default energy bids are the CAISO's estimate of a resource's marginal cost. The competitive locational marginal price is a location-specific price that includes all congestion from constraints that pass the competitiveness test. It represents the going rate for competitive energy at

the relevant location and ensures resources are mitigated only to the extent needed to resolve market power for higher-priced bids.

The CAISO proposes to calculate a "default capacity bid" for imbalance reserves and reliability capacity based upon the historical spinning reserves clearing prices (the approach is discussed Section 4.6.3). The CAISO also proposes to calculate a "competitive capacity price" for imbalance reserves that excludes non-competitive congestion prices similar to the competitive locational marginal price used in energy offer mitigation. The calculated "competitive" prices in the market power mitigation process is meant to keep offers from being mitigated below estimated competitive prices, even if those prices are above a resource's estimated marginal cost. In the event the resource's imbalance reserve bid needs to be mitigated the mitigated bid price will be the greater of the default capacity bid or the competitive capacity price. If the resource's imbalance reserve bid is less that the default capacity bid or the competitive capacity price, no modification will be made to the resource's imbalance reserve bid.

4.2 Integrated Forward Market Changes

The integrated forward market obtains a full market solution using mitigated bids from the market power mitigation pass. The integrated forward market solves the optimal unit commitment to clear bid-in load, bid-in supply, imports, exports, and ancillary services requirements. The CAISO proposes to enhance the day-ahead market by introducing a new day-ahead market imbalance reserves product co-optimized and procured in the integrated forward market.

Energy (EN)

The energy (EN) schedule will be the same day-ahead market schedule that results from the current integrated forward market. The market determines energy schedules by clearing physical and virtual supply against bid-in load and virtual demand. The energy will continue to be priced at each node resulting in a locational marginal price. Resources with a day-ahead energy schedule can re-bid (self-schedule or economically bid) the energy into the real-time market.

Ancillary Services

The day-ahead market procures 100 percent of the expected requirement for four ancillary services:

- Regulation up is procured from certified resources that can respond to the 4 second automated generation control signal to address increases in the net load that occur within a five minute dispatch interval.
- Regulation down is procured from certified resources that can respond to the 4 second automated generation control signal to address decrease in the net load that occur within a five minute dispatch interval.
- Spinning reserves are procured from certified resources that are synchronized to the grid and can be called upon if a contingency event occurs.
- Non-spinning reserves are procured from certified resources that either are or are not synchronized to the grid and can be called upon if a contingency event occurs.

The CAISO is not proposing any changes to ancillary services procurement. They will continue to be procured on a system and regional basis as opposed to a nodal basis and subject to the existing cascading procurement rules where regulation up can substitute for spinning and non-spinning reserves, and spinning reserve can substitute for non-spinning reserve.[7]

Imbalance Reserves (IRU/IRD)

Imbalance reserves will ensure the integrated forward market schedules sufficient real-time dispatch capability to meet net load imbalances between the day-ahead and real-time markets. These imbalances are due to net load uncertainty and granularity differences between hourly day-ahead market and fifteen-minute real-time market schedules. Imbalance reserves will be comprised of imbalance reserves up (IRU) that will provide upward dispatch capability and imbalance reserves down (IRD) that will provide downward dispatch capability. An imbalance reserve schedule will result in an obligation to provide economic energy bids to the real-time market. The market may schedule a resource to provide both IRU and IRD.

The integrated forward market will co-optimize and procure imbalance reserves to meet the imbalance reserve requirement. The market optimization will consider transmission constraints to ensure imbalance reserves are deliverable using imbalance reserve deployment scenarios. The market will price imbalance reserves at each node reflecting deliverability constraints.

In this second revised straw proposal, the CAISO no longer proposes, as it did in previous proposals, that the integrated forward market procure imbalance reserves based on a demand curve. Using a demand curve could result in the integrated forward market relaxing the imbalance reserve requirement based on market clearing prices. This could result in insufficient capacity to meet real-time ramping needs and net load uncertainty. The integrated forward market could be particularly prone to relaxing the imbalance reserve requirement when there were high energy prices because large amounts of self-scheduled exports or exports economically bid at high prices. If the market does not procure the full imbalance reserve requirement, system operators may continue to perform the out-of-market actions that imbalance reserves are intended to prevent. Exports should not prevent the market from procuring capacity needed to ensure CAISO balancing authority area reliability.

In this second revised straw proposal, the CAISO proposes to procure 100 percent of the imbalance reserve requirement in the integrated forward market, similar to ancillary services. The penalty price to relax procurement of imbalance reserves will be less than ancillary services and self-schedule load but higher than low-priority (LPT) self-scheduled exports (see Table 3). This ensures that the integrated forward market will not clear low-priority exports unless there is sufficient supply above what is needed to meet real-time net load uncertainty.

[7] The CAISO does have a planned initiative on its Annual Policy Initiative Roadmap to consider deliverability and re-optimization of ancillary services in both FMM and RTD.
http://www.caiso.com/InitiativeDocuments/2021PolicyInitiativesRoadmap-Updated.pdf

Table 3: Imbalance Reserve Penalty Price in IFM

Penalty Price Description	**Scheduling Run Value based on $1000 Cap**	**Pricing Run Value based on $1000 Cap**	**Scheduling Run Value based on $2000 cap**	**Pricing Run Value based on $2000 cap**
Ancillary Service Region Regulation-up and Regulation-down Minimum Requirements	2500	250	5000	250
Ancillary Service Region Spin Minimum Requirements	2250	249	4500	249
Ancillary Service Region Non-Spin Minimum Requirements	2000	248	4000	248
Self-scheduled CAISO demand, self-scheduled export using identified non-RA supply resources, and export leg of wheel through self-schedules	1800	1000	3600	2000
Imbalance reserve up requirement	**1600***	**247***	**3200***	**247***
Self-scheduled exports not using identified non-RA supply resource	1050	1000	2100	2000

**Values are for illustrative purposes only. Actual implemented penalty price values may differ.*

Imbalance reserves will enable the day-ahead market to compensate resources that provide flexible capacity to meet net load uncertainty. Today, system operators may take out-of-market actions, including conforming load and issuing exceptional dispatches to secure additional supply to increase the ramp capability available to the real-time market and to address uncertainty between the day-ahead and real-time markets. System operators have increasingly taken such actions because of the increased variability resulting from increasing amounts of variable energy resources. Imbalance reserves will minimize the need for these out-of-market actions and will create a market price signal for flexibility.

The day-ahead market will only award imbalance reserves to resources that are dispatchable in the fifteen-minute market. Although the day-ahead market will schedule imbalance reserves hourly, it will procure them based on a resource's fifteen-minute ramp capability.

Imbalance Reserve Requirements

This section provides a high-level overview of the method used to calculate the imbalance reserve requirements in the day-ahead market. This method intends to align with the approach proposed for the flexible ramping product requirements.[8]

Historical data will be used to identify the net load forecast error between the day-ahead market and fifteen-minute market. These historical net load forecast errors will then be used to determine the imbalance reserves up and down requirement based on the prevailing load, wind, and solar forecasts for each hour of each day using statistical regression. The CAISO proposes to use quantile regression to determine the imbalance reserve requirements. A quantile regression estimates quantiles of a dependent variable conditional on the values of a set of independent variables. A quantile regression is preferred to standard linear regression in this case because the imbalance reserve requirements are based on relatively extreme high and low (i.e., 97.5 and 2.5 percentile)[9] observations of net load imbalances, as opposed to the average net load imbalance. The regressors (independent variables) include the day-ahead load, solar, and wind forecasts, as well as the operating hour and month or season.

Imbalance Reserve Deliverability

Under this proposal, the market will consider transmission constraints when awarding imbalance reserves in the integrated forward market to ensure they are deliverable if deployed in real-time. The approach is similar to the upward and downward deployment scenarios developed in the flexible ramping product refinements initiative. These deployment scenarios will result in nodal imbalance reserves that ensure scheduled day-ahead physical supply can meet the uncertainty requirements if deployed without violating transmission constraints. The nodal approach results in more accurate prices for imbalance reserve awards because they represent a locational value of the capacity product, similar to energy.

The upward deployment scenario ensures physical supply and imbalance reserves up awards are deliverable to where upward net load uncertainty may materialize. The downward deployment scenario ensures physical supply less imbalance reserves down awards are deliverable to where the downward net load uncertainty may materialize. The net load uncertainty that materializes occurs at load nodes and variable energy resource nodes.

Bidding Rules

The CAISO proposes the following bidding rules for products procured in the integrated forward market:

- Market participants will submit separate bids for energy, ancillary services, IRU, and IRD.

[8] CAISO Flexible Ramping Product Refinements initiative. Appendix C – Quantile Regression Approach. http://www.caiso.com/InitiativeDocuments/AppendixC-QuantileRegressionApproach-FlexibleRampingProductRequirements.pdf

[9] The CAISO may buy less than this amount initially to gain experience with imbalance reserves during the transition period.

- Bids will continue to be submitted by 10:00 AM and can have hourly price curves, but with a single segment for capacity products.
- The capacity bid MW quantity must be greater than zero and will be capped by the associated certification quantities that would consider the resource ramp rate over the product horizon (e.g., imbalance reserves are fifteen-minute products, spinning and non-spinning reserves are ten-minute products).

Payments and Charges

The CAISO proposes the following day-ahead charges and payments for load, virtual supply, virtual demand, physical supply, imports, and exports. These resources will be settled for differences between the day-ahead energy schedule and real-time market energy schedule.

- Bid-in load will be charged the locational marginal price of its load aggregation point for energy.
- Internal generation, participating load models, imports, exports, virtual supply, and virtual demand will be paid/charged the locational marginal price for energy.
- Suppliers awarded ancillary services will be paid the ancillary service's marginal price.

The CAISO proposes the following day-ahead payments for eligible resources that are awarded imbalance reserve awards.

- Resources that receive an imbalance reserve up award will be paid the locational marginal price for imbalance reserves in the upward direction.
- Resources that receive an imbalance reserve down award will be paid the locational marginal price for imbalance reserves in the downward direction.

Imbalance Reserve Cost Allocation

Imbalance reserves are needed because system conditions change between day-ahead and real-time, which requires the re-dispatch of available resources in real time. For example, if a generator or an import is unable to meet its day-ahead energy schedule, another resource must be scheduled in FMM to replace the lost supply. In the event a variable energy resource submits a self-schedule and its forecast exceeds its day-ahead schedule, all else being equal, a dispatchable resource will need to be scheduled below its day-ahead schedule. Imbalance reserves up/down costs will be allocated as follows:

Imbalance Reserves Up

- Tier 1
    - Generation: MAX(0, Day-ahead energy schedule – FMM upper economic limit as affected by de-rates)
    - Load: Negative uninstructed imbalance energy
    - Imports: MAX(0, Day-ahead energy schedule – FMM upper economic limit as affected by e-Tag transmission profile)
    - Exports: MIN(0, FMM self-schedule – Day-ahead energy schedule)
- Tier 2

- Metered demand

The price used for the imbalance reserve up tier 1 cost allocation is the minimum of the imbalance reserve up price and the imbalance reserve up derived price. The imbalance reserve up derived price is the imbalance reserve up cost divided by the imbalance reserve up tier 1 allocation quantity.

Imbalance Reserves Down

- Tier 1
  - Generation: MAX(0, FMM lower economic limit as affected by rerates – Day-ahead energy schedule)
  - Load: Positive uninstructed imbalance energy
  - Imports: MIN(0, MAX(e-Tag transmission profile, FMM self-schedule) – Day-ahead energy schedule)
  - Exports: MAX(0, Day-ahead energy schedule – e-Tag transmission profile)
- Tier 2
  - Metered demand

The price used for the imbalance reserve down tier 1 cost allocation is the minimum of the imbalance reserve down price and the imbalance reserve down derived price. The imbalance reserve down derived price is the imbalance reserve down cost divided by the imbalance reserve down tier 1 allocation quantity.

Imbalance Reserve Unavailability No Pay

Capacity that is not available in real time reduces the available supply of real-time energy and flexible ramping product and drives up their price. A stronger incentive than a no-pay mechanism is needed to ensure resources follow through on their must-offer obligations. Resources should be penalized commensurate with the harm they cause to the system by not being available. The CAISO proposes to implement the following unavailability penalties for imbalance reserves:

Imbalance reserves up: Resources with an upper economic limit that does not support their day-ahead energy + IRU award less the 5-minute uncertainty award in FMM[10] will be charged the higher of the RTPD FRU price, the RTD FRU price, or the IRU price.

Imbalance reserves down: Resources with a lower economic limit that does not support their day-ahead energy - IRD award plus the 5-minute uncertainty award in FMM will be charged the higher of the RTPD FRD price, the RTD FRD price, or the IRD price.

These unavailability penalties provide a strong incentive to deliver imbalance reserves and reflect the full cost of unavailability. That is because suppliers can be charged the cost of real-time flexible ramping product, whose price may spike because of a shortage of flexible capacity, for the portion of their award

[10] In Section 4.5, the proposed settlement of ramp deviation is discussed. This term is included so that a resource is not charged no pay and a deviation settlement for ramp when unavailable.

that was not provided. Resources that receive both a reliability capacity and imbalance reserve award and are not available or only bid a portion of their combined award will have the unavailability charge applied first to reliability capacity and then to imbalance reserves.

Bid Cost Recovery

Currently, bid cost recovery is calculated separately for the day-ahead and real-time market. This will not change. However, the revenue and bid costs from imbalance reserve awards will be included in the calculation of day-ahead bid cost recovery. Resources committed in the integrated forward market, including resources that are scheduled for imbalance reserves, will receive day-ahead bid cost recovery.

Application of Grid Management Charge to Imbalance Reserves

The market services charge of the grid management charge covers the cost of bidding and clearing the market. Currently, the market services charge is applied to ancillary services awards in the day-ahead market and real-time market. Suppliers include this cost in the bid price for ancillary services. The market services charge is not applied to the flexible ramping product and corrective capacity because suppliers are not allowed to submit bids for those products. Since bids can be submitted for imbalance reserves, the market services charge will be applied for imbalance reserve awards. Suppliers will include this cost in their bids.

4.3 Market Power Mitigation Pass for RUC (New)

Reliability capacity up and down awards are priced in RUC at locational marginal prices that have marginal congestion contributions from binding constraints. Therefore, market power mitigation is also required for reliability capacity bids in RUC. This is achieved by adding a market power mitigation pass after IFM and before RUC. In the market power mitigation pass for RUC, the market will use unmitigated reliability capacity bids to procure reliability capacity to meet the CAISO net demand forecast.

In the market power mitigation pass for RUC, the market will use unmitigated reliability bids to clear the CAISO net demand forecast. Binding transmission constraints in the base scenario (cleared CAISO net load) are evaluated to determine if they are uncompetitive. Resources with a net positive marginal congestion contribution from uncompetitive constraints will have their reliability capacity bids mitigated. Energy and/or imbalance reserve bids are mitigated above the corresponding competitive marginal price, which is the marginal price without contributions from uncompetitive binding constraints.

The CAISO proposes to calculate a “default capacity bid” for reliability capacity based upon the historical spinning reserves clearing prices. Since the same approach will be used for imbalance reserves, the approach is discussed Section 4.6.3. The CAISO also proposes to calculate a “competitive capacity price” for reliability capacity that excludes non-competitive congestion prices similar to the competitive locational marginal price used in energy offer mitigation. The calculated “competitive” prices in the market power mitigation process is meant to keep offers from being mitigated below estimated competitive prices, even if those prices are above a resource’s estimated marginal cost.

In the event the resource's reliability bid needs to be mitigated the mitigated bid price will be the greater of the default capacity bid or the competitive capacity price. If the resource's reliability bid is less that the default capacity bid or the competitive capacity price, no modification will be made to the resource's reliability capacity bid.

The feasibility for this proposed new market power mitigation pass between IFM and RUC for mitigating reliability capacity bids will depend ensuring that the overall process fits comfortably within the allotted market solution time from 10:00 AM to 1:00 PM. To aid in the performance and solution time of the overall day-ahead market, the CAISO proposes to limit the RUC market power mitigation pass to a 24-hour horizon, rather than RUC's default optimization horizon of 72 hours. Any mitigated bid in the 24-hour RUC market power mitigation pass will apply across the 72-hour RUC optimization.

4.4 Residual Unit Commitment Changes

The residual unit commitment process runs after the integrated forward market produces energy schedules. The residual unit commitment process procures incremental capacity to meet reliability needs. The residual unit commitment process procures incremental capacity based on the forecast of CAISO net demand. The need for incremental capacity is based on the difference between the amount of physical energy that clears the integrated forward market and the amount of physical energy needed to meet the net demand forecast.

The CAISO proposes several enhancements to the residual unit commitment process. First, physical capacity will be procured in the residual unit commitment through a new day-ahead market product called reliability capacity. Reliability capacity can be procured in the upward or downward direction. Second, the residual unit commitment will be able to transition multi-stage generating resources in the downward direction (but not turn them off completely) and will establish their binding configuration. Third, a new market power mitigation pass will precede the residual unit commitment to determine competitiveness of reliability capacity bids. These enhancements are described in detail in the following sections.

Reliability Capacity (RCU/RCD)

The proposed reliability capacity product will improve the existing residual unit commitment process as the mechanism to ensure the day-ahead market schedules sufficient capacity to meet the net load forecast. Unlike the existing residual unit commitment process, reliability capacity will provide both upward and downward dispatch capability. If the CAISO's net load forecast is greater than the non-VER physical supply that clears the integrated forward market, the residual unit commitment process will procure reliability capacity up to provide upward dispatch capability and/or commit additional units. If the net load forecast is less than the non-VER physical supply that clears the integrated forward market, the residual unit commitment process will procure reliability capacity down to provide downward dispatch capability.

Similar to the existing residual unit commitment process, the market optimization will consider transmission constraints in scheduling reliability capacity. In addition, transmission constraints will be

enforced in the reliability capacity up and down deployment scenarios, similarly to the imbalance reserve up and down deployment scenarios in IFM, to assure the deliverability of reliability capacity awards. Energy schedules, imbalance reserve awards, and ancillary services awards will be held fixed in RUC at their integrated forward market schedules. In order to resolve congestion differences that may exist between IFM and RUC, this will be addressed through reliability capacity awards. A reliability capacity award results in an obligation to provide economic energy bids to the real-time market. Resources awarded reliability capacity will have their reliability capacity schedule settled at a reliability capacity locational marginal price. The market will recover the costs of reliability capacity through a cost allocation including allocation to virtual supply and demand.

A resource's 60-minute ramp capability limits the amount of its reliability capacity awards. A resource can receive reliability capacity awards only in one direction (i.e., either reliability capacity up or reliability capacity down).

Multi-Stage Generating Resource Configuration in the Residual Unit Commitment

Currently, multi-stage generating resource configurations are committed in the integrated forward market. These commitments are passed to the residual unit commitment as an input. The residual unit commitment is able to commit multi-stage generating resources or transition them to a higher configuration. System operators report seeing congestion or oversupply in the residual unit commitment where multi-stage generating resources should be allowed to transition downward but the current residual unit commitment does not have that functionality. This causes system operators to exceptionally dispatch the units down manually.

The CAISO proposes to allow the residual unit commitment to transition multi-stage generating resources in the downward direction but not turn them off completely (i.e., transition down to their lowest configuration range but not shut down). This will help manage congestion in the residual unit commitment and avoid out-of-market actions by system operators.

Reliability Capacity Bidding Rules

The CAISO proposes the following bidding rules for products procured in the residual unit commitment process:

- Market participants will submit separate bids for RCU and RCD.
- RCU and RCD bids will continue to be submitted by 10:00 AM and can have hourly price curves, but with a single quantity segment.
- The capacity bid MW quantity must be greater than zero and will be capped by the associated resource's 60-minute ramp rate over the product horizon.

Reliability Capacity Payments

The CAISO proposes the following day-ahead payments for eligible resources that are awarded reliability capacity awards.

- Resources that receive a reliability capacity up or down award will be paid the locational marginal price for reliability capacity in the upward or downward direction, respectively.

Reliability Capacity Cost Allocation

Reliability capacity will have a direct settlement to generation, imports, and exports. It is appropriate to design a cost allocation for these reliability capacity payments that builds off the existing cost allocation for the residual unit commitment and accounts for the drivers of reliability capacity needs (load, virtual bids, and VERs[11]). The uplift cost for reliability capacity will be allocated as follows:

Reliability Capacity Up

- RCU Tier 1 cost is allocated to net virtual supply, under-scheduled load, and over-scheduled (non-forecasted) variable energy resources.
    - The net virtual supply allocation quantity will be a maximum of (a) zero or (b) scheduling coordinator net virtual supply awards. Thus, net virtual demand does not net against the other allocation bases for RCU. This assumes a balancing authority area total net virtual supply.
    - Under-scheduled load will be defined using net negative metered demand. The net negative metered demand will exclude net negative demand associated with balanced ETC/TOR rights, negative deviation for Participating Load resulting from a market dispatch, and metered sub-systems that have elected not to participate in reliability capacity.
    - The over-scheduled (non-forecasted) variable energy resource allocation quantity will be a maximum of (a) zero or (b) sum of the non-forecasted variable energy resource day-ahead schedules less their day-ahead VER forecast. Thus, under-scheduled variable resources do not net against the other allocation bases for RCU. This assumes the balancing authority area has a total net over-scheduled (non-forecasted) variable energy.
- RCU Tier 2 cost is allocated to metered demand.

The CAISO also proposes that RCU Tier 1 costs should be limited by the minimum of the RCU capacity price and the RCU Tier 1 price.[12] In other words, if the RCU obligation is higher than the RCU awards, all of the cost will be allocated to RCU Tier 1. If RCU awards are greater than the RCU obligation, then costs will be split between Tier 1 and Tier 2.

Reliability Capacity Down

- RCD Tier 1 cost is allocated to net virtual demand, over-scheduled load, and under-scheduled (non-forecasted) variable energy resources.

[11] VERs can avoid being allocated reliability capacity by participating as a "forecasted variable energy resource". See Section 4.6.4.

[12] RCU Tier 1 price is the minimum of the RCU allocation price and the RCU capacity price. The RCU allocation price is the RCU cost divided by the total RCU Tier 1 allocation quantity. RCD Tier 1 price is calculated similarly.

  - The net virtual demand allocation quantity will be a maximum of (a) zero or (b) scheduling coordinator net virtual demand awards. Thus, net virtual supply does not net against the other allocation bases for RCD. This assumes a balancing authority area total net virtual demand.
  - Over-scheduled load will be defined using net positive metered demand. The net positive metered demand will exclude net positive demand associated with balanced ETC/TOR rights, positive deviation for Participating Load resulting from a market dispatch, and metered sub-systems that have elected not to participate in reliability capacity.
- RCD Tier 2 cost is allocated to metered demand.

Since all variable energy resource can be awarded RCD, unlike RCU, non-forecasted VERS are not included in the RCD cost allocation.

The CAISO also proposes that RCD Tier 1 costs should be limited by the minimum of the RCD capacity price and the RCD Tier 1 price. In other words, if the RCD obligation is higher than the RCD awards, all of the cost will be allocated to RCD Tier 1. If RCD awards are greater than the RCD obligation, then costs will be split between Tier 1 and Tier 2.

Reliability Capacity Unavailability No Pay

Capacity that is not available in real time reduces the available supply of real-time energy and flexible ramping product and drives up their price. A stronger incentive than a no-pay mechanism is needed to ensure resources follow through on their must offer obligations. Resources should be penalized commensurate with the harm they cause to the system by not being available. The CAISO proposes to implement the following unavailability penalties for reliability capacity:

Reliability capacity up: Resources with an upper economic limit that does not support their day-ahead energy + RCU award will be charged the higher of the RTPD FRU price or the RCU price.

Reliability capacity down: Resources with a lower economic limit that does not support their day-ahead energy - RCD award will be charged the higher of the RTPD FRD price or the RCD price.

These unavailability penalties provide a strong incentive to deliver reliability capacity and reflect the full cost of unavailability. That is because suppliers can be charged the cost of real-time flexible ramping product, whose price may spike because of a shortage of flexible capacity, for the portion of their award that was not provided. Resources that receive both a reliability capacity and imbalance reserve award and are not available or only bid a portion of their combined award will have the unavailability charge applied first to reliability capacity and then to imbalance reserves.

Bid Cost Recovery

Currently, bid cost recovery is calculated separately for the day-ahead and real-time market. This will not change. However, bid cost recovery for resources committed in the residual unit commitment process are able to receive real-time bid cost recovery. The revenue and bid costs from reliability

capacity awards will be included in the calculation of real-time bid cost recovery. Resources committed after the close of the day-ahead market through a real-time market schedule or an exceptional dispatch will also continue to receive real-time bid cost recovery.

Any surplus revenues from the residual unit commitment process will be netted against revenue shortfalls in the real-time market. A revenue surplus would occur in the residual unit commitment when the marginal price of reliability capacity exceeds a resource's reliability capacity bid cost. Conversely, any surplus revenues from the real-time market will be netted against revenue shortfalls in the residual unit commitment process. Bid cost recovery payments from the integrated forward market and the residual unit commitment/real-time market will continue to be kept separate because they have different cost allocations (IFM has a two-tier allocation while RUC/RTM has one tier).

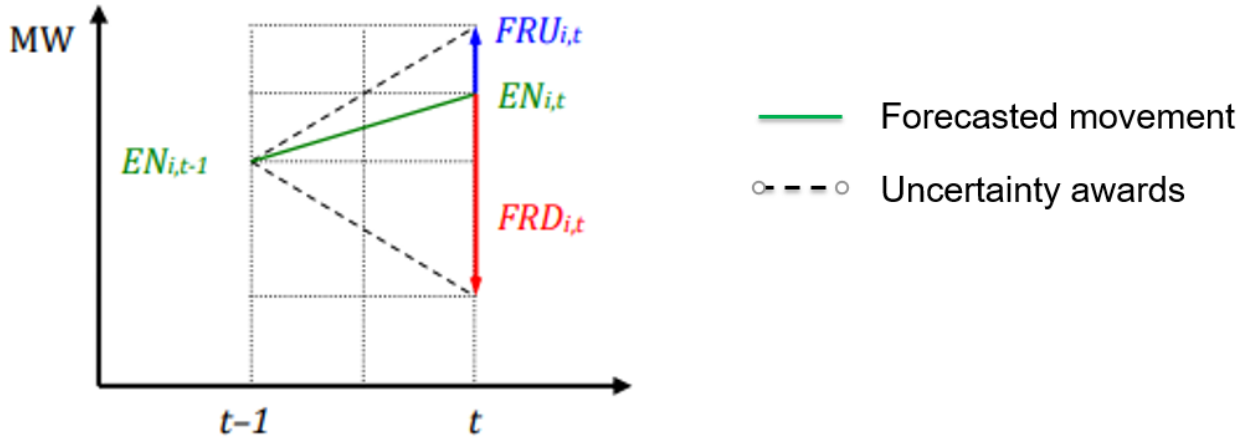
Application of Grid Management Charge to Reliability Capacity

The market services charge of the grid management charge covers the cost of bidding and clearing the market. Currently, the market services charge is applied to ancillary services awards in the day-ahead market and real-time market. Suppliers include this cost in the bid price for ancillary services. The market services charge is not applied to the flexible ramping product and corrective capacity because suppliers are not allowed to submit bids for those products. Since bids can be submitted for reliability capacity, the market services charge will be applied for reliability capacity awards. Suppliers will include this cost in their bids.

4.5 Real-Time Market Ramp Deviation Settlement

The deviation settlement of ramp involves two components: (1) forecasted movement and (2) uncertainty awards (see Figure). Forecasted movement is the change in energy schedules between market intervals in a given market run. Uncertainty awards are additional ramping capability not scheduled for energy needed to meet net load forecast uncertainty in the next market run. The marginal value of providing ramp capability is the same for both forecasted movement and uncertainty awards.

Figure 7: Forecasted movement and uncertainty awards



Imbalance reserves in the day-ahead market and flexible ramping product in the real-time market both provide additional capacity for ramping. Market payments for the provision of ramping services should net in each market. However, there are differences in the configuration, eligibility, and pricing of these products that make a direct deviation settlement infeasible. Table 4 describes these differences.

Table 4: Differences between Imbalance Reserves and Flexible Ramping Product

Imbalance Reserves	**Flexible Ramping Product**
Single settlement (uncertainty)	Dual settlement (uncertainty and forecasted movement)
Awards based on resource's 15-min ramp capability	Awards based on resource's 5-min ramp capability
Clearing price based on bids and opportunity cost	Clearing price based only on opportunity cost

A deviation settlement for ramp is necessary to resolve the following issues:

- **Double payment of opportunity costs.** Resources that receive an imbalance reserve award in the IFM are paid the locational marginal price of imbalance reserves for the corresponding interval. The locational marginal price of imbalance reserves is based on two factors: imbalance reserve bids and any opportunity costs. Opportunity costs for imbalance reserves occur when a resource is held out of merit for energy or ancillary services to preserve its ramp capability to provide upward capacity to meet the uncertainty requirements in a given interval. Similarly, opportunity costs for energy can occur when a resource is held out of merit for energy in order to preserve its downward capability to provide sufficient ramping to meet the load in a subsequent interval. The market clearing price of flexible ramping product is based only on opportunity costs; there are no bids associated with this product. A resource awarded both products could thus be paid opportunity costs for both imbalance reserves and again for the flexible ramping product even if its energy and ancillary service schedules did not change. This represents a double payment. However, the resource should retain its imbalance reserve bid costs, which reflect the resource's marginal cost of being available for dispatch in the real-time market.
- **Double payment of forecasted movement.** In the day-ahead market, all hourly schedules are financially binding across the 24-hour horizon. That is, there are no unsettled advisory intervals in the day-ahead market. As a result, there is no need to settle forecasted movement in the day-ahead market because the energy prices already reflect the opportunity cost of resources scheduled out-of-merit in previous hourly intervals. However, in the real-time market, only one market interval is financially binding over the optimization horizon. The market produces unsettled "advisory" prices for the remaining market intervals. If a resource is dispatched for energy in the binding interval to provide ramp capability to meet the energy dispatch of an advisory interval, the resource can incur an opportunity cost if the binding interval price is less than its energy bid. If in this market run the resource incurs an opportunity cost, the advisory interval energy price will increase to reflect this tradeoff. However, the advisory interval energy

price is not settled, and when it becomes binding in the next market run, the out-of-merit dispatch is unknown and the opportunity cost is not embedded in the binding energy price. In order to compensate the resource, it receives a separate payment for forecasted movement at the marginal price of ramp capability.[13] This incentivizes the resource to follow its energy dispatch because the resource is indifferent to receiving an incremental energy schedule or a forecasted movement payment because it earns the same profit under both scenarios. However, a resource may receive compensation for forecasted movement both in the day-ahead market (embedded in the energy prices) and in the real-time market (as a side payment). This represents a double payment.

- **Unavailability drives up prices.** Capacity that is not available in real-time reduces the available supply of ramp and drives up its price. Therefore, resources that do not provide the ramp they are obligated to should settle those deviations at prices reflecting real-time conditions.

The proposed settlement for imbalance reserves has several aspects:

- Imbalance reserve is 15-minute ramp capability reserved for use in FMM to address the granularity difference between IFM and FMM, and uncertainty that may materialize in FMM and RTD. The uncertainty that may materialize in RTD is addressed by the flexible ramping product, which is 5-minute ramp capability reserved in FMM and RTD. Therefore, the 5-minute ramp-capable portion of imbalance reserve can be procured as flexible ramping product in FMM. Consequently, the 5-minute ramp-capable portion of an imbalance reserve award is subject to a deviation settlement with a flexible ramping product award in FMM.
- The portion of an imbalance reserve award in excess of the 5-minute ramp-capable portion can be scheduled as energy in FMM to address the granularity difference between IFM and FMM, and uncertainty that may materialize in FMM. This portion of imbalance reserve is not subject to a deviation settlement. However, if any of this portion is unavailable due to outages, it is subject to no pay provisions at the higher of the IFM marginal price for imbalance reserves or the FMM marginal price for flexible ramping product.
- Imbalance reserve and flexible ramping product awards are complementary for forecasted movement. Forecasted movement is the energy schedule difference between adjacent intervals in the same market run. The ramp capability of a resource may manifest as forecasted energy between energy schedules or it may be awarded as uncertainty awards, or any combination in between. The forecasted movement is not settled in the IFM because all IFM energy schedules for all hours are settled, thus the IFM forecasted movement settlement is embedded in the IFM energy settlement. However, because in FMM and RTD only the binding energy schedule is settled, the FMM and RTD forecasted movement deviations, from IFM and FMM respectively, are explicitly settled. Forecasted movement deviation up is paid the flexible ramp up price and charged the flexible ramp down price, and vice-versa.
- The overall settlement of these complementary products has the following property: If the 5-minute ramp capability that is awarded in IFM (as either energy movement or an imbalance

[13] See Section 7.1.3.1.4 of the Market Operations BPM for numerical examples.

reserve award) is available and awarded in FMM (as either forecasted movement or a flexible ramping product award), there is no net deviation settlement in FMM. Furthermore, if the 5-minute ramp capability that is awarded in FMM is available and awarded in RTD (as either forecasted movement or a flexible ramping product award), there is no net deviation settlement in RTD.

The CAISO has published an Excel spreadsheet model[14] that illustrates that if the 5-minute ramp capability of a resource is awarded between forecasted movement and uncertainty awards the same across markets, from IFM to FMM to RTD, there are no net payments or charges due to deviations in the real-time market. Changes in the 5-minute ramp capability awards across markets occur when resources reach their PMin or PMax at a different time than in the preceding market, there is a ramp rate de-rate, or the resource's ramp capability is not fully used.

Impacts to EIM from Ramp Settlement

The Energy Imbalance Market also procures flexible ramping product to commit and position resources to meet future load and supply variability and uncertainty. Therefore, EIM participants will also be subject to FMM forecasted movement deviation settlement based on EIM base schedules. For EIM participants, forecasted movement from base schedules is equivalent to forecasted movement in the integrated forward market.

Impact to Convergence Bidding from Ramp Settlement

Convergence bids, also known as virtual bids, are settled at the day-ahead price and then automatically liquidated in the FMM. Virtual supply is paid the IFM price and charged the FMM price. Virtual demand is charged the IFM price and paid the FMM price. Since the IFM energy price includes the settlement of forecasted movement, virtual supply and demand will have a forecasted movement deviation settlement and the FMM FRP price.

4.6 Additional Design Considerations

4.6.1 Congestion Revenue Rights

Congestion revenue rights (CRRs) are CAISO forward market products that hedge integrated forward market congestion costs. The CAISO proposes to expand CRRs to provide a hedge for the congestion cost due to binding transmission constraints in the imbalance reserve deployment scenarios in the integrated forward market. The marginal congestion component of the energy LMP will include shadow price contributions from these constraints; hence, it is appropriate for CRRs to provide an additional hedge against these components.

Today, CRRs receive congestion revenues collected in the integrated forward market on each binding transmission constraint between the CRR source and sink. The CRR settlement is at the difference between the marginal congestion components of the energy LMP at the sink and source of the CRR. The

[14] FMM and RTD Settlement Example - Day-Ahead Market Enhancements. http://www.caiso.com/InitiativeDocuments/FMM-RTDSettlementExample-Day-AheadMarketEnhancements.xlsx

settlement for CRR Obligations is algebraic; it can be a payment or a charge. However, the settlement for CRR Options is capped from below to zero (i.e., it is never a charge). Furthermore, the CRR payments due to a binding constraint are adjusted so that they do not exceed the congestion revenue collected due to that constraint. All binding constraints, from both the base case and contingencies are considered. With DAME, any additional base case and contingency constraints that are binding in the imbalance reserve deployment scenarios will also be considered.

No changes are proposed to the existing CRR Nomination and Auction processes. Imbalance reserve deployment scenarios need not be modelled in the CRR Nomination and Auction processes. No CRR revenue shortfall is expected because this because congestion revenue is collected on the transmission capacity that is reserved in IFM for IRU/IRD deployment through the binding transmission constraints in the IRU/IRD deployment scenarios.

4.6.2 Accounting for Energy Offer Cost in Upward Capacity Procurement

Suppliers offering upward capacity in the day-ahead market would presumably bid their cost of making the resource available in real-time. However, if two resources have the same real-time availability bid but different energy costs, the optimization cannot differentiate between the two resources. In this situation, the optimal solution would be to award imbalance reserve up or reliability capacity up to the resource with unloaded capacity with the lowest underlying energy cost because it would be most cost-effective if needed in real time.

Currently the day-ahead market does not attempt to distinguish the energy cost of resources when awarding existing reserve products such as spinning reserves. This is not as much of a concern for contingency reserves because the real-time market only dispatches reserves during relatively infrequent contingency events. A resource's energy cost is a greater concern for reliability capacity and imbalance reserves because there is a higher likelihood of being dispatched for energy in the real-time market. Thus, this proposal implements rules that distinguish resources with high energy costs when awarding upward reliability capacity and imbalance reserves.

Previously, the CAISO proposed a real-time energy offer cap for resources awarded upward reliability capacity and imbalance reserves. The real-time energy offer cap would be set at the marginal price of meeting the P97.5 net load forecast using all available day-ahead energy bids. The purpose of the offer cap was to incentivize resources with energy costs above the cap to increase their capacity offers to make up for potential unrecovered variable energy costs due to real-time dispatch. By increasing their capacity offers, it would make those resources less likely to be awarded upward capacity.

In response to stakeholder feedback, the CAISO is proposing a different mechanism that more simply and directly meets the objective of accounting for energy offer cost in upward capacity procurement. The CAISO would still estimate the marginal price of meeting the P97.5 net load forecast using all available day-ahead energy bids. However, instead of using this price to set a real-time energy offer cap, the CAISO proposes that resources would be ineligible for RCU and IRU awards on any capacity segment with an associated energy bid that exceeds the forecasted P97.5 price.

For example, consider a resource with an energy bid curve of 0-50MW @ $100, 50-100MW @ $250, 100-150MW @ $450, 150-175MW @ $500. Assume the forecasted P97.5 price for the hour is $400. This resource would be ineligible to provide RCU or IRU on any capacity segment above 100MW.

4.6.3 Calculation of Default Capacity Bid

The CAISO proposes to set the "default capacity bid" for imbalance reserves and reliability capacity to establish a minimum capacity offer to mitigate resources. This default capacity bid will be a single default bid for all resources. The CAISO, in consultation with stakeholders, has been unable to establish a formula rate to establish the default capacity offer for each resource. The CAISO believes that the historical spinning reserve price can be used to establish the minimum capacity. The CAISO previously proposed 90th percentile or $30; however, by now proposing to calculate a competitive capacity price the CAISO seeks stakeholder input on the appropriate historical percentile that best approximates the real-time availability cost of their resources. Table 5 provides the historical spinning reserve bid and market clearing prices by percentile.

Table 5: Percentiles of bid and cleared prices for spinning reserves (Jan 2017-Mar 2019)

Percentile	Bid Price
50	$ 24.18
55	$ 25.09
60	$ 26.11
65	$ 26.98
70	$ 27.92
75	$ 28.83
80	$ 29.84
85	$ 31.45
90	$ 33.39

Percentile	Cleared Price
50	$ 4.69
55	$ 5.34
60	$ 6.33
65	$ 7.57
70	$ 8.77
75	$ 10.00
80	$ 11.41
85	$ 13.49
90	$ 16.60

Source: CAISO analysis

As discussed in section 4.6.5, during the transition period, resource adequacy resources and resources designated to support a PT export will be required to bid $0 for imbalance reserves and reliability capacity. This will provide additional time to review the default capacity bid and its relationship to the spin price prior to allowing bidding for imbalance reserves and reliability capacity for all resources.

4.6.4 Variable Energy Resources Eligibility to Provide New Products

In response to stakeholder comments, the CAISO will propose two participation options for variable energy resources in the day-ahead market. Option 1 will allow the resource to participate in the same manner as variable energy resources do today. The resource will determine its upper economic limit through its bid curve. The CAISO is calling these resources "non-forecasted" variable energy resources. Option 2 will allow the resource to participate in the day-ahead market based upon the CAISO hourly day-ahead forecast. The resource's upper economic limit is set to the CAISO forecast. The CAISO is calling these resources "forecasted" variable energy resources. The selection of the participation option will be a Master File selection.

Non-Forecasted Variable Energy Resources

Selecting the option to participate as a non-forecasted variable energy resource results in the following:

- Eligible for RCD or IRD awards
- Not eligible for RCU or IRU awards
- Subject to cost allocation of reliability capacity up
- Subject to cost allocation of imbalance reserves

The restriction on awarding the upward capacity products to non-forecasted variable energy resources addresses the CAISO's concern of awarding energy and the upward capacity products above the CAISO forecast. From a CAISO operations perspective, this would undermine the reliability of the market and could create the need for out-of-market actions the CAISO is seeking to minimize. For example, assume the CAISO forecast is 100 MW and the energy offer from the resource allows a schedule at 110 MW of energy, 10 MW of imbalance reserves up, and 10 MW of reliability capacity up. The market would be counting the resource as physically capable of providing 130 MW of energy and capacity, but from a reliability perspective, the CAISO can only rely on the resource for 100 MW and would need to take out-of-market actions to procure 30 MW of capacity from another physical resource. The restriction from awarding the upward capacity products does not change the ability of the resource to be cleared at a higher level in the real-time market based upon the real-time forecast.

A similar concern does not exist for the downward capacity products because the downward capacity awards must be less than or equal to the energy schedule. A resource provides downward capacity below its day-ahead energy schedule. Its downward capability cannot exceed the full energy schedule. Since variable energy resources' real-time energy offer curves use the CAISO forecast as the upper economic limit, having variable energy resources establish a maximum energy level in the real-time market that could be self-scheduled provides a valuable service to manage over supply in the real-time market. For example, assume a resource had an energy schedule of 50 MW and an imbalance reserves down award of 20 MW. The resource could not submit a self-schedule exceeding 30 MW. If the real-time forecast were 65 MW, there would be 35 MW dispatch range. If the real-time forecast were 40 MW, there would be a 10 MW dispatch range.

Since the scheduling coordinator's day-ahead offers are not consistent with the CAISO forecast, differences can result in the need to clear more reliability capacity down if the CAISO forecast is higher than the resource's offers and more reliability capacity up of the CAISO forecast is lower than the resource's offers. Therefore, non-forecasted variable energy resources will be included in the cost allocation of reliability capacity up.

Forecasted Variable Energy Resources

Selecting the option to participate as a forecasted variable energy resource results in the following:

- Eligible for RCD, IRD, RCU, IRD awards
- Not subject to cost allocation of reliability capacity up
- Subject to cost allocation of imbalance reserves

Forecasted variable energy resources can provide upward reliability capacity and upward imbalance reserves because the CAISO forecast is used as the upper economic limit of the resources day-ahead bid curve. This will ensure the resource's energy schedule does not exceed the system operator's forecast. Unlike the real-time market, resources will not be allowed to submit their own forecast to be used for settlement purposes. If resources have concerns regarding the CAISO's forecast and want to take a different position in the day-ahead market, they will be able to account for differences between their forecast and the system operator forecast using virtual bids. The market participant will know the CAISO's forecast for variable energy resources prior to the bid submission deadline for the day-ahead market.

If a resource's own forecast is higher than the CAISO's forecast of their resource, the market participant will be able to submit virtual supply offers for the difference. The virtual supply has the effect of extending the resource's energy bid curve to the resource's forecast. If a resource's forecast is lower than the system operator forecast, the market participant could submit virtual demand offers. The virtual demand has the effect of shortening the resource's bid curve to the resource's forecast (or desired day-ahead market position). The use of virtual bids will enable the market participant to have its preferred day-ahead position energy settled at the day-ahead price. The CAISO has posted an Excel worksheet that illustrates the use of virtual bids to address differences in the forecasted energy with the straw proposal of this initiative. Cleared virtual supply and demand are subject to the cost allocation of reliability capacity.

Forecasted variable energy resources can self-schedule in the day-ahead market; however, only resources that submit economic bids will be scheduled to provide reliability capacity or imbalance reserves. If a variable energy resource is awarded reliability capacity or imbalance reserves, the resource will have the same real-time bidding obligations as other resources. Since the day-ahead market is clearing based upon the CAISO forecast, there is no need for reliability capacity so the resource is not subject to the cost allocation of reliability capacity. In addition, the calculation of reliability capacity in the residual unit commitment uses the energy schedule rather than the CAISO forecast and the deployment scenarios likewise recognize that forecasted variable energy resources can provide the upward capacity products. This is because the forecasted variable energy resources can be scheduled economically below their full output, which reflects the desired energy output of the resource.

4.6.5 Transition Period

The CAISO is proposing a transition period for the day-ahead market enhancements. During the transition period, resource adequacy resources will still be required to meet their real-time must offer obligations regardless of the resource's reliability capacity or imbalance reserve award. During this time, resource adequacy resources will bid $0.00 for both reliability capacity and imbalance reserves; however, resource adequacy resources will be paid the marginal price for both reliability capacity and imbalance reserves. While the marginal price should be zero in most cases, there can be instances where a resource is scheduled out-of-merit for energy, resulting in an opportunity cost that is compensated through the price of reliability capacity and imbalance reserves. Non-RA resources

designated to support a PT export will also have a requirement to bid $0 for reliability capacity up to the quantity being used to support the PT export.

The rationale for this transition period is to allow the CAISO to:

- Observe how the new market performs
- Make any necessary adjustments to certain market design elements such as the imbalance reserve requirement
- Provide time for load serving entities to transition contracts to a paradigm of non-zero RUC availability bids for resource adequacy capacity
- Analyze the existing resource adequacy real-time must-offer obligation paradigm
- Inform further flexible resource adequacy analysis and refinement
- Evaluate using historical spin prices to establish a default capacity bid
- Evaluate setting of the price threshold for imbalance reserve up and reliability capacity up eligibility.

The transition period will end at the start of the calendar year in which EIM entities will onboard into the extended day-ahead market. For example, the day-ahead market enhancements are scheduled to be implemented in fall 2022. The extended day-ahead market is planned for implementation in fall 2023 to support onboarding in spring 2024. The current schedule would result in the transition period ending on January 1, 2024. In the event the extended day-ahead market onboarding occurred in spring 2025, the transition period would be extended another year. The DAME independently provide s benefits in terms of resource adequacy efficiency, which would still merit an eventual end to the transition period. The CAISO, with the support of the Market Surveillance Committee, has argued that compensating resources for making capacity available through market bids, rather than through resource adequacy contract payments, is a more efficient way to allocate reliability capacity and imbalance reserve capacity. That is because resources can reflect their costs of making capacity available through their bids; thus, market-clearing prices would better reflect market conditions, which would incentivize resources to provide reliability capacity and imbalance reserves when and where they are needed.

4.6.6 Treatment of Metered Subsystems, Existing Transmission Contracts, and Transmission Ownerships Rights

Metered Subsystems

Currently, metered subsystem operators must make an election on four issues that govern the manner in which the metered subsystem participates in the markets. The metered subsystem operator must choose either:

i. Net settlements or gross settlements.
ii. To load follow or not to load follow with its generating resources.
iii. To have its load participate in residual unit commitment procurement or not have its load participate in residual unit commitment procurement.
iv. To charge or not to charge the CAISO for their emissions costs.

With the day-ahead market enhancements, metered subsystem operators must make an election on three issues that will govern the manner in which the metered subsystem participates in the markets. The metered subsystem operator must choose either:

i. Net settlements or gross settlements.
ii. To load follow or not load follow with its designated generating resources.
iii. To charge or not to charge the CAISO for their emissions costs.

A metered subsystem operator may:

i. Bid to supply energy to or purchase energy from the markets.
ii. Bid to provide available capacity for imbalance reserves up/down to meet uncertainty requirements.
iii. Bid to provide available capacity for reliability capacity up/down to meet net load forecast
iv. Bid or self-provide an ancillary service from a system unit or from individual generating units, participating loads or proxy demand response resources within the metered subsystem. A metered subsystem operator also may purchase ancillary services from CAISO or third parties to meet its ancillary service obligations under the CAISO tariff.

The CAISO proposes to maintain the current settlement of metered subsystem operator day-ahead energy schedules who have elected gross settlement or net settlement. The CAISO proposes to settle metered subsystem resources that have received imbalance reserves or reliability capacity awards in a similar manner as non-metered subsystem resources, regardless of the metered subsystem operator's selection of net or gross settlement. Imbalance reserve up/down awards will settle at the relevant locational marginal price for imbalance reserves. Reliability capacity up/down awards will settle at the relevant locational marginal price for reliability capacity. For both reliability capacity tier 1 and reliability capacity tier 2 cost allocations, metered subsystem operators will settle in a similar manner as non-metered subsystem resources, regardless of their net versus gross selection. A metered subsystem operator that has elected to load follow to manage its own load variability shall not receive a reliability capacity tier 1 or a reliability capacity tier 2 cost allocation. For both imbalance reserve tier 1 and imbalance reserve tier 2 cost allocations, metered subsystem operators will settle in a similar manner as non-metered subsystem resources, regardless of their net versus gross selection. A metered subsystem operator that has elected to load follow to manage its own load variability shall receive imbalance reserve tier 1 and imbalance reserve tier 2 cost allocations based on the metered subsystem operator's net portfolio uninstructed deviations.

Existing Transmission Contracts and Transmission Ownership Rights

The CAISO proposes to maintain the current energy settlement for existing transmission contract rights (ETCs) and transmission ownership rights (TORs). Day-ahead energy schedules associated with an ETC or TOR self-schedule will settle at the relevant integrated forward market locational marginal price. In addition, the CAISO proposes to maintain the settlement of integrated forward market congestion credit for the valid and balanced portion of ETC or TOR self-schedules and relative eligible point of receipt of delivery.

Reliability capacity will ensure sufficient physical resources are committed to meet the net load forecast with adjustments for known differences between what cleared the integrated forward market including under-scheduled variable energy resources. As long as the ETC/TOR self-schedules supply to meet their demand, the market does not need to procure reliability capacity to meet the valid and balanced portion of ETC or TOR self-schedule. As such, the CAISO proposes to exclude the ETC and TOR self-schedules from reliability capacity tier 1 and reliability capacity tier 2 allocations up to the valid and balanced portion of ETC and TOR self-schedules. In contrast, the ETC and TOR self-schedules are subject to reliability capacity tier 1 and reliability capacity tier 2 allocations for quantities above the valid and balanced portion of the ETC or TOR self-schedules.

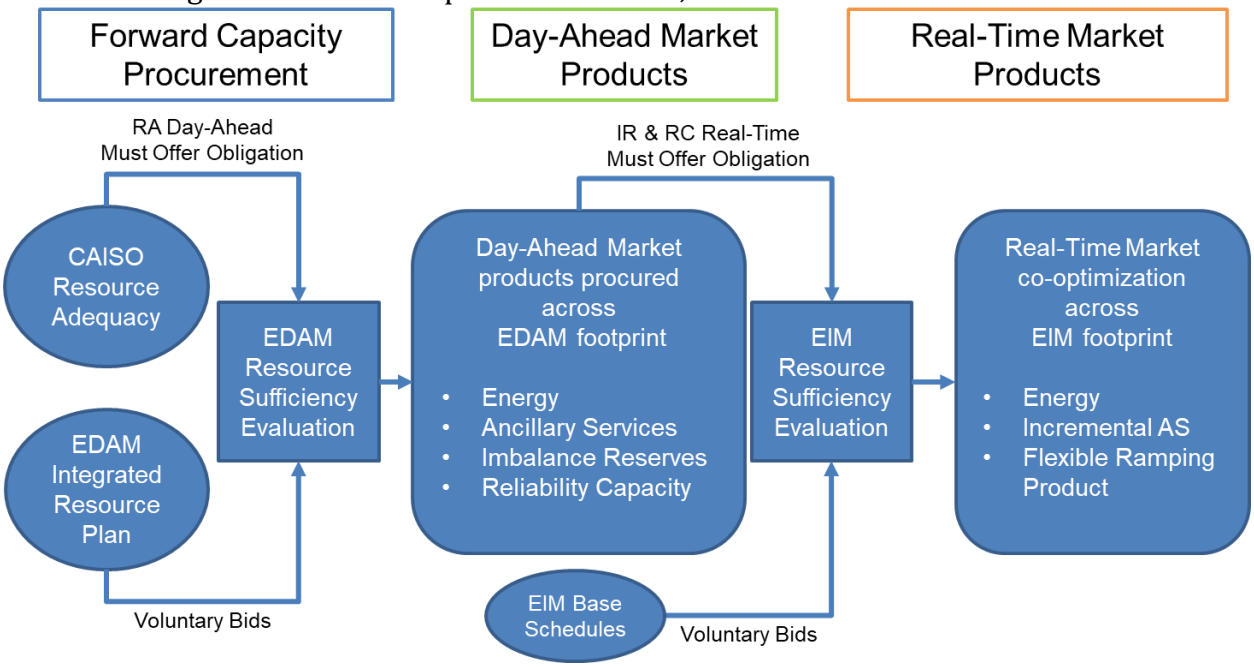
Imbalance reserves will ensure the day-ahead market schedules sufficient real-time dispatch capability to meet net load imbalances between the day-ahead and real-time markets. As long as the ETC and TOR self-schedules supply to meet their demand, the CAISO does not need to procure additional imbalance reserves. As such, the CAISO is proposing to exclude the ETC and TOR self-schedules from imbalance reserve tier 1 and imbalance reserve tier 2 allocations up to the valid and balanced portion of ETC and TOR self-schedules. In contrast, the ETC and TOR self-schedules are subject to imbalance reserve tier 1 and imbalance reserve tier 2 allocations for quantities above the valid and balanced portion of the ETC or TOR self-schedules.

5. Alignment between RA Enhancements, DAME, and EDAM

The CAISO is coordinating the stakeholder initiatives for the Resource Adequacy Enhancements, Day-Ahead Market Enhancements, and Extended Day-Ahead Market to ensure alignment and consistency in determining forward capacity procurement requirements, bidding obligations, and market solutions. The goal of this effort is to ensure an efficient and robust market design that bridges the various election/bidding and program/market timelines.

Figure 8 is a flowchart depicting the correlation between RA Enhancements, DAME, and EDAM.

Figure 8: Relationship between DAME, EDAM and RA Enhancements



The flowchart can be summarized as follows:

1. The CAISO resource adequacy program or an EIM entity's integrated resource plan ensure the balancing authority area has access to adequate supply capacity to meet anticipated system needs. These programs enable energy imbalance market (EIM) participants to enter the EDAM with sufficient resources to meet their own load requirements. The EDAM resource sufficiency evaluation is intended to ensure each EIM entity and the CAISO have sufficient bid range from participating resources to individually meet bid-in demand, ancillary services requirements, reliability capacity, and their share of imbalance reserves. Assuming the EIM entity passes the EDAM resource sufficiency evaluation, it will be eligible to participate in the day-ahead market and can benefit from EDAM transfers.

2. Participants in the EDAM will have their energy and ancillary services co-optimized to meet daily load and reliability requirements. Once the day-ahead market enhancements have been implemented, this co-optimization will also include the new day-ahead market product called imbalance reserves to cover net load uncertainty in each balancing authority area. In addition, the residual unit commitment will procure reliability capacity in each EDAM balancing authority area across the EDAM footprint to meet difference in cleared physical supply and the net load forecast. Balancing authority areas participating in the EIM but not in the EDAM will continue to provide EIM base schedules. The day-ahead market will result in must offer obligations and bids into the real-time market. In order to participate in the real-time market, a balancing authority area must pass the EIM real-time resource sufficiency test.

3. The real-time market will co-optimize energy, incremental ancillary services, and real-time flexible ramping product across the entire EIM footprint.[15]

The CAISO acknowledges this new design differs from existing functionality. Currently, resource adequacy provisions create a must offer obligation in both the day-ahead and real-time market, depending on the characteristics of the resource. Under the redesign, the CAISO resource adequacy provisions will still impose a day-ahead must offer obligation. The nature of the real-time must offer obligation, however, will change. The real-time obligation currently is based on a resource's start-up time and its status as a resource adequacy resource. Going forward, the real-time obligation for all resources, including resource adequacy resources, will be based on imbalance reserve and reliability capacity schedules.

Day-Ahead Market Enhancements (DAME) & Extended Day-Ahead Market (EDAM)

Some stakeholders have requested that both the DAME and EDAM initiatives take place within the same stakeholder forum. While the CAISO is committed to aligning the objectives and functionalities of these initiatives, they will continue as distinct stakeholder processes. The day-ahead market enhancements lay the foundation for EDAM. However, the day-ahead market enhancements will be implemented for the CAISO balancing authority area regardless of the outcome of EDAM. Stated explicitly, the CAISO will pursue DAME even if, for whatever reason, EDAM does not move forward. For this reason, it is critical to keep the initiatives, board decisions, FERC filings, and implementations separate.

Nevertheless, it is critical to explain the DAME elements that are foundational for EDAM. The benefit of EDAM is to utilize the diverse resources across balancing authority areas to meet load and operational needs across the west more efficiently. Imbalance reserves resulting from the DAME initiative are necessary to facilitate the EDAM because they enable the diversity benefit to share flexibility obligations for the uncertainty between day-ahead and real-time markets. Imbalance reserves will allow resources in one balancing authority area to be compensated for providing flexibility to another balancing authority area. Reliability capacity is needed to ensure additional physical supply is committed to cover differences in cleared physical supply and the EDAM footprint net load forecast. The integrated forward market is a financial market where bid-in load clears against bid-in supply while also meeting the ancillary services and imbalance reserve requirements, whereas the residual unit commitment is a physical market that clears physical supply to meet the net load forecast. The day-ahead market and appropriate scheduling priorities for EDAM transfers can eliminate the need for an EDAM entity to commit a generator with high costs to be ready for potential real-time imbalances, and instead allow the EDAM entity to purchase (at lower cost) imbalance reserves and reliability capacity from another entity. This will be the primary benefit of the EDAM.

[15] The Energy Imbalance Market does not procure incremental ancillary services outside of the CAISO balancing authority area.

6. EIM Governing Body Role

ISO management believes the EIM Governing Body should have an advisory role in the approval of all of proposed market enhancements resulting from this initiative.

Under the decisional classification rules in the Guidance Document and Charter for EIM Governance, the EIM Governing Body would have no decisional role concerning the changes to day-ahead market rule that are proposed in this initiative. Those changes fall outside the CAISO Board of Governors' delegation of authority to the EIM Governing Body.

These proposed changes to day-ahead market rules, however, which would change the structure of the day-ahead market and introduce a day-ahead imbalance reserve product, are intended to lay the foundation for a future initiative that would give EIM Entities the option of participating in the day-ahead market. Given the unique foundational nature of the initiative, Management believes it would be appropriate for the EIM Governing Body to have an advisory role on all aspects of this initiative. This would be consistent with the intentions of the EIM Transitional Committee, which expected that EIM Governance would have a role in "decisions … that would … [a]llow options to expand the functionality of the market to provide additional services …." Final Proposal, August 19, 2015, p.14.[16]

This latest proposal also includes proposed changes to real-time market rules that are generally applicable to the entire market. Accordingly, the advisory classification includes these proposed changes as well. This proposed decisional classification may need to be modified later, though, as this policy initiative evolves. If it changed further to include changes to EIM-specific rules of the real-time market, the CAISO's recommendation on the decisional classification would be revised to reflect such changes.

Stakeholders are encouraged to submit a response to the EIM categorization in their written comments following the conference call for this revised straw proposal, particularly if they have concerns or questions.

7. Stakeholder Engagement, Implementation Plan & Next Steps

Table 6 below outlines the proposed schedule to complete the policy for the Day-Ahead Market Enhancements initiative:

Table 6: Stakeholder engagement and implementation development plan

Date	Milestone
Second Revised Straw Proposal	
Paper Posted	July 21, 2021
Stakeholder Meeting	July 28 and 29, 2021
Comments Due	August 18, 2021

[16] https://www.westerneim.com/Documents/Decision_EIM_Governance_Proposal-Proposal-Aug2015.pdf

Draft Final Proposal	
Post Paper - *tentative*	September 15, 2021
Stakeholder Meeting - *tentative*	September 23, 2021
Comments Due - *tentative*	October 8, 2021
Start Tariff Stakeholder Process	Mid-September 2021
Start Business Requirement Specification (BRS) Development	Mid-September 2021
EIM Governing Body	October 20, 2021
CAISO Board of Governors	November 3-4, 2021
Implementation	Fall 2022

The CAISO will discuss the second revised straw proposal with stakeholders during the stakeholder calls scheduled on July 28 and 29. Stakeholders should submit comments on the proposal and meeting discussions through the ISO's commenting tool, using the link on the initiative webpage by close of business on August 18, 2021.

Appendices

Appendix A: Eligibility Table

	EN	RCU	RCD	EN needed for RCU/D award	IRU	IRD	EN needed for IRU award	EN needed for IRD award
Non-Participating Load	Yes	Not Eligible	Not Eligible	N/A	Not Eligible	Not Eligible	N/A	N/A
Virtual Supply	Yes	Not Eligible	Not Eligible	N/A	Not Eligible	Not Eligible	N/A	N/A
Virtual Demand	Yes	Not Eligible	Not Eligible	N/A	Not Eligible	Not Eligible	N/A	N/A
Hourly Block Import	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A
Hourly Block Export	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A
15-Min Import	Yes	Eligible	Eligible	None	Eligible	Eligible	None	EN >= IRD
15-Min Export	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= IRU	None
Dynamic Import	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Long-Start Generator	Yes	Eligible	Eligible	EN >= Pmin	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Short-Start Generator	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Participating Load w/ 15-Min dispatch capability	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax - IRU	EN <= Pmax EN >= Pmin + IRD
Participating Load w/ Hourly dispatch capability	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A

	EN	RCU	RCD	EN needed for RCU/D award	IRU	IRD	EN needed for IRU award	EN needed for IRD award
Forecasted Intermittent Resources (Wind/Solar)	Yes Upper economic limit set at CAISO forecast	Eligible	Eligible	EN + RCU <= CAISO forecast	Eligible	Eligible	EN >= Pmin EN + IRU <= CAISO forecast	EN <= CAISO forecast
Non-Forecasted Intermittent Resources (Wind/Solar)	Yes	Not Eligible	Eligible	EN <= CAISO forecast	Not Eligible	Eligible	N/A	EN <= CAISO forecast
Non-Generator Resources (Storage)	Yes	Eligible	Eligible	N/A	Eligible	Eligible	N/A	N/A
60-Minute Proxy Demand Resource	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A
15-Minute Proxy Demand Resource	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax – IRU	EN <= Pmax EN >= Pmin + IRD
5-Minute Proxy Demand Resource	Yes	Eligible	Eligible	None	Eligible	Eligible	EN >= Pmin EN <= Pmax – IRU	EN <= Pmax EN >= Pmin + IRD
Reliability Demand Response Resource	Yes	Eligible	Eligible	None	Not Eligible	Not Eligible	N/A	N/A

Appendix B: Draft Technical Description

See separate document.